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**THE NEXT ASSIGNMENT:
THE STATE OF THE LITERATURE ON SPACE**

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It is both an honor and a pleasure to have been invited to address this conference on the history of space activity. My topic concerns the state of literature on space. It is both a survey of what I believe to be the most worthwhile sources for information on the space age to date, as well as a commentary on the areas of interest that have attracted the attention of commentators and historians. Finally, I attempt to posit some notions of what we should do in the field of aerospace historiography over the coming few years. While not vast, respectable literature on the history of space activity is already large enough to warrant our review. For this reason, symposiums such as this can serve a most useful function in enabling us to take stock periodically of what has been done.

To date, the literature on the space program has broken down into works treating major topics, such as theoretical underpinnings and biographies; survey histories; studies in comparative history; the legal and political aspects of spaceflight; the postwar period through the impact of *Sputnik*; comparative and detailed examinations of the American-Soviet space rivalry; the implications of space for defense; the heroic era of American space exploration; social commentaries on the space program; memoirs of space explorers; and, last but not least, the dreams of futurists. The works discussed in this paper constitute what I believe to be the more significant works in these fields; it is a very personal interpretation, and certainly open for comment and suggestions by others.

The exploration of space is a 20th-century happening made possible by the development of large rocket boosters capable of placing various kinds of payloads into space. The development of this technology involved complex interrelationships between technologists, the scientific community, federal and military research organizations, the national defense establishment, and those charged with responsibility for foreign and domestic policy. It is not a uniquely American story, though the openness of the American space program has aided those historians, social scientists, and practitioners of science and technology who have chosen to examine various facets of space utilization and exploration.

The three major pioneers of the modern space age were Konstantin Tsiolkovskii, Hermann Oberth, and Robert H. Goddard. Tsiolkovskii's writings and notes have been published in Russian and translated as the *Collected Works of K.E. Tsiolkovskiy* in three volumes, edited by Anatoliy A. Blagonravov (NASA, 1965). Oberth's *Wege zur Raumschif-*

fahrt and *Die Rakete zu den Planetenräumen* have been translated and published by NASA as well, as *Ways to Spaceflight* (1972) and *Rockets into Planetary Space* (1965). The American Robert Goddard is the subject of an excellent biography by Milton Lehman, *This High Man* (Farrar, Straus, 1963), that concentrates on Goddard's trials and tribulations, as well as his occasionally mystical and secretive nature. Goddard's own reports, notes, and papers have been published in three volumes, *The Papers of Robert H. Goddard* (McGraw-Hill, 1970), edited by Esther C. Goddard (his widow) and G. Edward Pendray.

The history of rocketry itself is a broad topic, and the literature is vast and mixed in quality. A good introduction to the technology is Eugene M. Emme's *The History of Rocket Technology: Essays on Research, Development, and Utility* (Wayne State University Press, 1964), a series of essays by practitioners, economists, and historians on various topics ranging from early satellite proposals to rocket airplanes and the origins of space telemetry. Bruce Mazlish has undertaken an ambitious comparative study of the growth of the railroad and the emergence of the space program in *The Railroad and the Space Program: An Exploration in Historical Analogy* (MIT Press, 1965), with essays by such noted authorities as Alfred Chandler, Robert Fogel, Thomas Parke Hughes, and Leo Marx, in an effort to study the impact of both the railroad and the space program upon American society.

The exploration of space is not, of course, purely a matter of science and technology. There are also important questions concerning the rights of nations and the conduct of international affairs, as the recent crash of a Soviet satellite in Canada, the well-publicized reentry of Skylab, and concern over space broadcasting and remote-sensing satellites all indicate. A useful introduction to joint efforts in exploration and utilization of space is Arnold W. Frutkin's *International Cooperation in Space* (Prentice-Hall, 1965), which examines the various international considerations that can influence the conduct of technology and science. George S. Robinson's *Living in Outer Space* (Public Affairs Press, 1975) furnishes the perspective of a lawyer on the legal aspects of spaceflight.

Generally, the history of spaceflight can be arranged to reflect four major periods: the early years of large rocketry, beginning in the 1930s, but with special emphasis on German efforts and the immediate postwar years; *Sputnik* and its aftermath, with the emergence of a "space race," and the first utilization of space; the "heroic era" of manned spaceflight, to the landing of Apollo 11 on the Moon; and the post-Apollo years. The single best source book on rocket development in Nazi Germany and the subsequent influence of Wernher von Braun's "Peenemunde team"

upon American rocketry is Frederick I. Ordway III and Mitchell R. Sharpe, *The Rocket Team* (Thomas Y. Crowell Publishers, 1979), which is based on copious documentary research supported by extensive oral history interviews. An indigenous and highly successful American effort to build an upper atmospheric sounding rocket is gracefully and wittily treated by Milton W. Rosen in *The Viking Rocket Story* (Harper, 1955), written by a Viking project engineer in the halcyon days prior to *Sputnik*. The first American satellite effort, the Vanguard project, is thoroughly examined by Constance McLaughlin Green and Milton Lomask in *Vanguard: A History* (Smithsonian Institution Press, 1971), including the shattering effect that *Sputnik* had upon the program and its subsequent execution. The turbulence of the immediate post-*Sputnik* era is captured by a memoir of President Dwight D. Eisenhower's, "Missile Czar," James R. Killian, Jr., in *Sputnik, Scientists, and Eisenhower: A Memoir of the First Special Assistant to the President for Science and Technology* (MIT Press, 1977), which casts light on Washington's space politics milieu.

During the troubled days of the early space race, a variety of individuals attempted to study the Soviet space program from afar. Much of the contemporary literature is quite fanciful, but subsequent works have succeeded in generally portraying the origins, goals, and conduct of the Soviet space program with accuracy. A popular and well-written account that is the best journalistic work is Nicholas Daniloff's *The Kremlin and the Cosmos* (Knopf, 1972). Charles S. Sheldon of the Library of Congress has written extensively on the Soviet space program, producing the most authoritative and insightful works, especially his *Review of the Soviet Space Program with Comparative United States Data* (McGraw-Hill, 1968), *United States and Soviet Rivalry in Space: Who is Ahead, and How Do the Contenders Compare?* (Library of Congress, 1969), and *United States and Soviet Progress in Space: Summary Data through 1971 and a Forward Look* (Library of Congress, 1972).

Not all observers were restricted to studying from afar. One of the major developments of the space age has been the emergence of reconnaissance satellites using sophisticated electro-optical sensors to furnish strategic intelligence. Philip J. Klass, a technical journalist, has written perceptively and authoritatively of both Soviet and American "spy satellites" in his *Secret Sentries in Space* (Random House, 1971), including the ways in which such craft influence the conduct of foreign relations, and the basic technological questions involved in their design and employment, as well as the general history of intelligence gathering from space. The transfer of this technology to scientific exploration is

highlighted by Merton E. Davies and Bruce C. Murray in *The View from Space: Photographic Exploration of the Planets* (Columbia University Press, 1971), a fascinating historical, technological, and scientific study.

The "heroic era" of American manned spaceflight has been admirably treated by a series of NASA-sponsored histories that are remarkably free of the boosterism that so often afflicts official accounts. These studies are project-oriented, tracing the development of a specific program, but they also examine a number of other factors including social, political, and economic matters. They should serve as a model for all government historians. The American manned space program involved the Mercury, Gemini, and Apollo programs, as well as the post-Apollo Skylab and Apollo-Soyuz Test Project (the latter a joint U.S.-USSR mission). The following can all be recommended without reservation, and constitute just a sampling of the studies that the NASA History Office has sponsored: Loyd S. Swenson, Jr., James M. Grimwood, and Charles C. Alexander, *This New Ocean: A History of Project Mercury* (NASA, 1966); Barton C. Hacker and James M. Grimwood, *On the Shoulders of Titans: A History of Project Gemini* (NASA, 1977); R. Cargill Hall, *Lunar Impact: A History of Project Ranger* (NASA, 1977) (Ranger was an unmanned lunar exploration spacecraft); Courtney G. Brooks, James M. Grimwood, and Loyd S. Swenson, Jr., *Chariots for Apollo: A History of Manned Lunar Spacecraft* (NASA, 1979); Edward C. Ezell and Linda N. Ezell, *The Partnership: A History of the Apollo-Soyuz Test Project* (NASA, 1978). John Logsdon's *The Decision to Go to the Moon* constitutes not only an insightful and important reference on the political environment surrounding the decision to undertake Apollo, but a major pioneering study in analyzing the social, political, and economic impacts upon mid-20th-century technology. A good reference and introduction to the Apollo program and its social, political, technological, and scientific significance is Richard Hallion and Tom D. Crouch's *Apollo: Ten Years Since Tranquility Base* (National Air and Space Museum/Smithsonian Institution Press, 1979), a series of essays by authorities in various fields ranging from space art to lunar geology. Henry S. F. Cooper has written an excellent account of the near-loss of *Apollo 13* in *13: The Flight That Failed* (Dial Press, 1973). Planetary geologist Farouk El-Baz has examined the scientific harvest available from space sensing in *Astronaut Observations from the Apollo-Soyuz Mission* (National Air and Space Museum/Smithsonian Institution Press, 1977). One of the most imaginative aspects of the Apollo program was NASA's art project whereby leading artists were invited to record their impressions of the whole space effort. Two noted artists who were administrators of this pro-

gram, H. Lester Cooke and James Dean, have collected the reflective and often stimulating results of this project in *Eyewitness to Space: Paintings and Drawings Related to the Apollo Mission to the Moon* (Abrams, 1971).

Norman Mailer has written of what Apollo meant to him and the "Aquarius Generation" in his *Of a Fire on the Moon* (Little, Brown, 1969). Tom Wolfe, in his often zany and insightful *The Right Stuff* (Farrar Straus Giroux, 1979), has examined the world of the test pilot and astronaut, and the occasional tensions between the two. The best participant account of manned spaceflight—and one of the finest aviation memoirs written to date—is Michael Collins's humorous, thoughtful, and lively *Carrying the Fire: An Astronaut's Journeys* (Farrar Straus Giroux, 1974), a recollection of the Gemini and Apollo programs, and a host of other things, by the former command module pilot of *Apollo 11*.

The future of spaceflight is open to a wide range of speculation, particularly as the United States contemplates relatively routine Earth-orbital operations with the NASA Space Shuttle transportation system. What will be the nature of space exploration and utilization in the decades ahead? One glimpse is that of physicist Gerard K. O'Neill's *The High Frontier: Human Colonies in Space* (William Morrow, 1977). O'Neill envisions gigantic, high-technology, cost-effective space colonies orbiting the Earth and bringing almost unimaginable benefits to human society, a view sharply debated by technologists and social scientists alike. Nevertheless, it is useful for the historian to be aware of such works, and to recognize that the space practitioner today may well be regarded as a prophet tomorrow.

This represents but a brief sampling of the relevant literature available on the space program. It is, however, indicative of the topics that have interested historians and observers through the years.

One's first reaction to all this must be how *little* research has actually been done in a serious, scholarly vein on the space program. For example, our best sources on the Apollo program have been a series of histories and works generated by the federal government itself. To the historian, ever alert to the pitfalls of "official" history, it is refreshing, then, to note that these are remarkably frank works, and as historians we should doff our hats to their authors and the agencies responsible, particularly the NASA History Office.

A second reaction might be how little has been written even in a popular vein. Unlike aeronautics, which has been exhaustively examined by scholars and buffs alike, the space program has not produced the same

number of popular pieces or respectable organizations claiming to document its history. Thus, many of the basic secondary sources that a historian normally consults before embarking on a detailed research investigation are missing. It must be added, however, that some might well see this as a blessing. One problem faced by historians of aeronautics is the very bulk of the secondary material, and the fact that much of it is buff literature of doubtful value that often acts to hinder and sidetrack the historian trying to mine it for a few rare nuggets.

Clearly there is a serious need for good biographical studies of the principal pioneers—men such as von Braun, Walter Hohmann, and Korolyov. There is, for example, only one decent Goddard biography (that of Lehman), and it is, of course, now out of print. We do not yet understand the workings of the rocket community and rocketeers; biographies and autobiographies and memoirs would go a great distance in removing this deficiency. Fortunately, there is some evidence of a change taking place. The historical sessions of the American Institute of Aeronautics and Astronautics, the American Astronautical Society, and, especially, the International Academy of Astronautics have generated over the last 10 years an increasing number of excellent memoir papers and biographical articles on such individuals as Eugene Sanger and Guido von Pirquet. This is producing some useful raw data, together with insight into the comparative development of astronautics in various nations.

One historian whose work merits special attention is Frank Winter of the National Air and Space Museum, Smithsonian Institution. Winter has generated a number of articles over the last two decades documenting the early history of rocketry from antiquity to the end of the 19th century, unearthing many little-known, yet influential pioneers, and broadening our knowledge of more popular ones such as William Congreve and William Hale. Currently he is completing a study of the early rocket societies in the 1920s and 1930s and their subsequent contribution to the growth of astronautics technology. This study, when complete, should go far in increasing our understanding of how the pre-Second World War "rocket community" flourished, in much the same fashion that Tom D. Crouch's work on early American aviation brought new light to bear on that well-travelled, if little understood, period in aeronautical history.

Survey histories are needed on both the Soviet and American space programs. Information on the former, of course, is less easy to come by than that of the latter, though, thanks to the work of V.N. Sokolskii of the Soviet Academy of Sciences, a surprising amount of research has been undertaken and is now available to the West. A good survey of European rocketry needs to be done. Some popular accounts have, of course, been

written on these topics. What is needed is the scholar's touch—thorough research, precise and insightful writing, and the ability to concentrate on the forest of aerospace development as opposed to the trees of individual rockets, missiles, and spacecraft.

One of the problems in the history of science and technology has been the demand that the historian and writer be familiar with the science and/or technology of the subject they are discussing. This is especially true in the history of the space program. Mere economic analysis, which has worked passingly well in, for example, the history of air transportation, is insufficient here. What is needed is familiarity with the craft of spaceflight; otherwise, many of the actions of the space administrators and engineers are incomprehensible at worst and confusing and misleading at best. When, for example, historians examine the ballistic versus lifting reentry question that confronted America's space planners in the 1950s and 1960s, they will have to understand at least some of the mechanics of reentry from space and the problems that confront advocates of these respective systems. Yet, without resolution of this question, the whole structure of America's space program in the 1960s would have been vastly different. There are a variety of questions that await the historian who boldly plunges into the mass of official (and usually technical) documentation awaiting our attention: the space program's impact on modern industrial and governmental management techniques; the relationship between the civilian and military space efforts; the role of innovation and invention in space technology; the impact of the space program on our domestic life and in international affairs; the relationship between aerospace technology and technology as a whole; the ethics of rocketry as weaponry; the philosophical implications of our flight from the Earth. These are but a few. As we move firmly towards the third decade of spaceflight, let us note that the history and literature of the space program can be likened to a rocket just after ignition. The clarity of our perceptions may be still obscured by the steamy blast of contemporary events, but the launch is go, and the promise and challenge of our task remain to be fulfilled.