

Steven J. Dick is the Chief Historian for NASA. He worked as an astronomer and historian of science at the U.S. Naval Observatory in Washington, DC, for 24 years before coming to NASA Headquarters in 2003. Among his most recent books are *Critical Issues in the History of Spaceflight* (2006, edited with Roger Launius), *Risk and Exploration: Earth, Sea and the Stars* (2005, edited with Keith Cowing), *The Living Universe: NASA and the Development of Astrobiology* (2004), and *Sky and Ocean Joined: The U.S. Naval Observatory, 1830–2000* (2003). He is the recipient of the Navy Meritorious Civilian Service Medal and the NASA Group Achievement Award, and he is a member of the International Academy of Astronautics and the International Astronomical Union.

Roger D. Launius is a member of the Division of Space History at the Smithsonian Institution's National Air and Space Museum in Washington, DC. Between 1990 and 2002, he served as Chief Historian of NASA. He has written or edited more than 20 books on aerospace history, including *Space: A Journey to Our Future* (2004), *Space Stations: Base Camps to the Stars* (2003), and *Flight: A Celebration of 100 Years in Art and Literature* (2003). His research interests encompass all areas of U.S. and space history and policy history, especially cultural aspects of the subject and the role of executive decision-makers and their efforts to define space exploration.



National Aeronautics and Space Administration
 NASA History Division
 Office of External Relations
 Washington, DC
 2007

On the back cover:

Eagle Nebula—The picture was taken on April 1, 1995 with the Hubble Space Telescope Wide Field and Planetary Camera 2. The color image is constructed from three separate images taken in the light of emission from different types of atoms. Red shows emission from singly-ionized sulfur atoms. Green shows emission from hydrogen. Blue shows light emitted by doubly-ionized oxygen atoms.

SOCIETAL IMPACT of SPACEFLIGHT

Steven J. Dick
 Roger D. Launius
 Editors



NASA
 SP-2007-4801



SOCIETAL
 IMPACT of
 SPACEFLIGHT

Steven J. Dick
 Roger D. Launius
 Editors



Since the dawn of spaceflight, advocates of a robust space effort have argued that human activity beyond Earth makes a significant difference in everyday life. Assertions abound about the “impact” of spaceflight on society and its relationship to the larger contours of human existence.

Fifty years after the Space Age began, it is time to examine the effects of spaceflight on society in a historically rigorous way. Has the Space Age indeed had a significant effect on society? If so, what are those influences? What do we mean by an “impact” on society? And what parts of society? Conversely, has society had any effect on spaceflight? What would be different had there been no Space Age? The purpose of this volume is to examine these and related questions through scholarly research, making use especially of the tools of the historian and the broader social sciences and humanities. Herein a stellar array of scholars does just that, and arrives at sometimes surprising conclusions.

Once contemplated, the subject is broad, rich and stimulating. Spaceflight has commercial and economic dimensions, as well as social, cultural, and ideological ramifications. It touches on enduring American values of pioneering, progress, enterprise, and rugged individualism. Worldwide it encompasses international cooperation and competition, and affects foreign policies, national security, and questions of the global environment. Viewing Earth from space, and space from the vicinity of Earth, alters world views, conceptions of self and others, and understandings of our place and purpose in the universe.

On the cover:

Top: This view of the rising Earth greeted the Apollo 8 astronauts as they came from behind the Moon after the lunar orbit insertion burn in December, 1968. Although the photo is commonly viewed as situated here, with Earth about five degrees off the horizon, the astronauts saw it as they rounded the moon with Earth to the left.

Bottom: Many humans thrill to the spectacle and the promise of spaceflight.

SOCIETAL
IMPACT *of*
SPACEFLIGHT

SOCIETAL IMPACT *of* SPACEFLIGHT

Steven J. Dick and Roger D. Launius
Editors



National Aeronautics and Space Administration
Office of External Relations
History Division
Washington, DC

2007

Library of Congress Cataloging-in-Publication Data

Societal impact of spaceflight / Steven J. Dick and Roger D. Launius, editors.

p. cm. — (The NASA history series, NASA SP-2007-4801)

Includes bibliographical references and index.

1. Astronautics and civilization. 2. Astronautics—United States—History. I. Dick, Steven J. II. Launius, Roger D.

CB440.S63 2007

303.48'3--dc22

2007042444

CONTENTS

INTRODUCTION ix

SECTION I SOCIETAL IMPACT OF SPACEFLIGHT IN CONTEXT

CHAPTER 1: Has Spaceflight Had an Impact on Society? An Interpretive Framework—Howard E. McCurdy 3

SECTION II TURNING POINT IMPACTS

CHAPTER 2: What Are Turning Points in History, and What Were They for the Space Age? —Roger D. Launius 19

CHAPTER 3: In Search of a Red Cosmos: Space Exploration, Public Culture, and Soviet Society —James T. Andrews 41

CHAPTER 4: Live from the Moon: The Societal Impact of Apollo —Andrew Chaikin 53

CHAPTER 5: Framing the Meanings of Spaceflight in the Shuttle Era —Valerie Neal 67

CHAPTER 6: Space in the Post-Cold War Environment —John M. Logsdon 89

CHAPTER 7: The *Taikonaut* as Icon: The Cultural and Political Significance of Yang Liwei, China's First Space Traveler—James R. Hansen 103

SECTION III COMMERCIAL AND ECONOMIC IMPACT

CHAPTER 8: Commercial and Economic Impact of Spaceflight: An Overview —Philip Scranton 121

CHAPTER 9: The Political Economy of Spaceflight—Stephen B. Johnson . . . 141

CHAPTER 10: The Role of Space Development in Globalization —James A. Vedda 193

CHAPTER 11: NASA as an Instrument of U.S. Foreign Policy —John Krige 207

CHAPTER 12: “From Farm to Fork”: How Space Food Standards Impacted the Food Industry and Changed Food Safety Standards —Jennifer Ross-Nazzari 219

CHAPTER 13: The Social and Economic Impact of Earth Observing Satellites —Henry R. Hertzfeld and Ray A. Williamson 237

SECTION IV APPLICATIONS SATELLITES, THE ENVIRONMENT, AND NATIONAL SECURITY

CHAPTER 14: Satellites and Security: Space in Service to Humanity —Erik Conway . . . . .	.267
CHAPTER 15: For All Mankind: Societal Impacts of Applications Satellites —David J. Whalen . . . . .	.289
CHAPTER 16: NASA and the Environment: Science in a Political Context —W. Henry Lambright . . . . .	.313
CHAPTER 17: NAVSTAR, the Global Positioning System: A Sampling of its Military, Civil, and Commercial Impact —Rick W. Sturdevant . . . . .	.331
CHAPTER 18: Dual-Use as Unintended Policy Driver: The American Bubble —Roger Handberg . . . . .	.353
CHAPTER 19: Reconnaissance Satellites, Intelligence, and National Security —Glenn Hastedt . . . . .	.369

SECTION V SOCIAL IMPACT

CHAPTER 20: Space History from the Bottom Up: Using Social History to Interpret the Societal Impact of Spaceflight —Glen Asner . . . . .	.387
CHAPTER 21: Space Science Education in the United States: The Good, the Bad, and the Ugly —Andrew Fraknoi . . . . .	.407
CHAPTER 22: “Racism, Sexism, and Space Ventures”: Civil Rights at NASA in the Nixon Era and Beyond —Kim McQuaid . . . . .	.421
CHAPTER 23: NASA Launches Houston into Orbit: The Political, Economic, and Social Impact of the Space Agency on the Southeast Texas, 1961–1969 —Kevin M. Brady . . . . .	.451
CHAPTER 24: The Jet Propulsion Lab (JPL) and Southern California —Peter J. Westwick . . . . .	.467

SECTION VI SPACEFLIGHT, CULTURE AND IDEOLOGY

CHAPTER 25: Overview: Ideology, Advocacy, and Spaceflight: Evolution of a Cultural Narrative —Linda Billings . . . . .	.483
CHAPTER 26: Spaceflight and Popular Culture —Ron Miller . . . . .	.501
CHAPTER 27: Making Spaceflight Modern: A Cultural History of the World’s First Space Advocacy Group —Asif A. Siddiqi . . . . .	.513

CHAPTER 28: C/SETI as Fiction: On James Gunn's <i>The Listeners</i> —De Witt Douglas Kilgore . . . . .	.539
CHAPTER 29: Reclaiming the Future: Space Advocacy and the Idea of Progress —Taylor E. Dark III . . . . .	.555
CHAPTER 30: Space Activism as an Epiphanic Belief System —Wendell Mendell . . . . .	.573
CHAPTER 31: Flights of Fancy: Outer Space and the European Imagination, 1923–1969 —Alexander Geppert . . . . .	.585
 SECTION VII AFTERWORD	
CHAPTER 32: Are We a Spacefaring Species? Acknowledging Our Physical Fragility as a First Step to Transcending It —M. G. Lord . . . . .	.603
CHAPTER 33: Production and Culture Together: Or, Space History and the Problem of Periodization in the Postwar Era —Martin J. Collins . . . . .	.615
ABOUT THE AUTHORS . . . . .	.631
THE NASA HISTORY SERIES . . . . .	.649
INDEX. . . . .	.659

INTRODUCTION

Fifty years after humanity first broke the gravitational bonds of Earth, the societal impact of spaceflight is a compelling subject whose time has come. It was recognized early in the Space Age that spaceflight would affect society. NASA's founding document, the National Aeronautics and Space Act of 1958, specifically charged the new Agency with eight objectives, including "the establishment of long-range studies of the potential benefits to be gained from, the opportunities for, and the problems involved in the utilization of aeronautical and space activities for peaceful and scientific purposes." Although the Space Act has been often amended, this provision has never changed, and still remains one of the main objectives of NASA.¹ Despite a few early studies, the mandate to study societal impact went unfulfilled as NASA concentrated on the many opportunities and technical problems of spaceflight itself.

It is time to take up the challenge once again. Multidecade programs to explore the planets, build and operate large space telescopes and space stations, or take humans to the Moon and Mars, require that the public have a vested interest. The same is true of the space activities now spread around the world. But whether or not the ambitious space visions of the United States and other countries are fulfilled, the question of societal impact over the past 50 years remains urgent and may in fact help fulfill current visions or at least raise the level of debate.

The subject of the societal impact of spaceflight, however, is not as simple as it may seem. Questions abound. Has the Space Age in fact had an impact on society? If so, what are those influences? What do we mean by "impact," "society," and "spaceflight"? And, realizing that society is not monolithic, what parts of society might have been affected? Conversely, has society had an effect on spaceflight? To put it another way, in the currently popular mode of counterfactual history, What would be different had there been no Space Age?²

It is with such questions in mind that the NASA History Division and the National Air and Space Museum's Division of Space History jointly organized a conference on the subject in Washington, DC from September 19–21, 2006. Because the scope of the societal impact of spaceflight is enormous, the planners had their work cut out for them in trying to establish some thematic coherence rather than merely presenting a hodgepodge of papers.

1. The National Aeronautics and Space Act and its complete legislative history may be found at <http://www.hq.nasa.gov/office/pao/History/spaceact-legishistory.pdf>. The passage quoted here is on page 6.

2. In the Prologue to his book *The Spaceflight Revolution* (NASA History Series SP-4308, Washington, DC, 1995), James Hansen (one of the authors in this volume) discusses at some length the importance and uses of counterfactual "what if" history in the context of spaceflight.

The themes that emerged, all infused with the underlying questions above, form the sections contained in this book.

First, it would seem obvious that certain turning points in the history of spaceflight must have had an impact: Sputnik, the Moon landing, and the Space Shuttle disasters are etched in memory for better or worse. But unpacking the nature and extent of that impact is no simple task. Secondly, a commercial and economic component to spaceflight is undeniable. It ranges from a far-reaching aerospace industry at one end of the spectrum to the famous (and sometimes literally legendary) “spinoffs” at the other end; it is a part of national and international political economy; and it has sometimes measurable but often elusive effects on daily life and commerce. Economic impact is closely related to a third area: applications satellites, which are in turn often inseparable from environmental issues and national security. Imaging the Earth from space and global space surveillance have played an arguably central role in the increasingly heated debate over climate change, and changed the manner in which national security issues are understood and interpreted. Just how central is a matter that only historical analysis can reveal. In a fourth domain, that of social impact, space activities have affected science, math, and engineering education; embodied questions of status, civil rights, and gender among other social issues; and led to the creation of “space states” such as California, Florida, and Texas. Finally, spaceflight has affected culture in multiple ways, ranging from worldviews altered or completely transformed by the images of Earth from space and the spectacular views of space from Earth-orbiting spacecraft, to our place in the universe made possible by studies of cosmic evolution and the search for extraterrestrial life and the embodiment of these and other themes in literature and the arts. Several essays in this volume also address issues of spaceflight, ideology, and culture, in particular the space movement and its links to ideas of progress and utopia.

These overarching themes in turn raise further questions. What is the difference between social impact and cultural impact? What is the interplay between spaceflight and those enduring American values of pioneering, progress, enterprise, and rugged individualism? How does this interplay differ from experiences in the Soviet/Russian, European, or Chinese milieu? How has spaceflight affected conceptions of self and others, as well as our understanding of purpose in the universe? In the end, all the themes in this volume form overlapping domains, and the attentive reader will find a synergy between the thematic sections in the book.

Although we believe we have captured many of the overarching themes, gaps undoubtedly remain, and at a lower level there is certainly no claim to be comprehensive, only an offer of representative exemplars from the major themes. In the area of commercial impact, for example, aside from applications satellites only one paper (Jennifer Ross-Nazzal) explicitly

addresses a commercial spinoff of the space program—the area most people think of immediately when and if they think at all about spaceflight and society. History, rather than public affairs, has an important role to play here in analyzing commercial impacts. An entire volume could be devoted to this subject alone, and further volumes in the NASA History Series will do so.

The themes of this volume also tie into deeper threads of contemporary intellectual argument. One has to do with the meaning of culture. More than 50 years ago two anthropologists collapsed 164 distinct definitions of culture into one: “[C]ulture is a product; is historical; includes ideas, pattern, and values; is selective; is learned; is based upon symbols; and is an abstraction from behavior and the products of behavior.”³ More recently Clifford Geertz defined culture as “an historically transmitted pattern of meanings embedded in symbolic forms by means of which men [people] communicate, perpetuate and develop their knowledge about and attitudes toward life.”⁴ According to Harvard biologist E. O. Wilson—famed for his work on sociobiology—each society creates culture and is created by it.⁵ In short, culture and society are moving targets, evolving with time and in space (perhaps literally in outer space); not only does Chinese culture differ from Western culture, both were different 50 years ago than they are now.

Another broadly related intellectual theme is postmodernism, the construction of our worldview. In the context of this volume one might well ask about the societal and cultural impact *on* spaceflight rather than *of* spaceflight. Glen Asner points out in his paper that little attention is given to the possibility of reverse effect in this volume, despite explicit requests in the call for papers (John Logsdon, with his examination of the impact of the post-Cold War environment, is one exception). As Asner puts it “The concept of societal impact is problematic to the extent that it is based on an assumption that the influence of spaceflight on society is more worthy of analysis than other conceptualizations of the relationship, such as the influence of society on spaceflight or the mutual shaping of spaceflight and society.”⁶ He suggests possibilities for examining the history of spaceflight by focusing on status, race, and gender in the context of work, the local community, and

3. Alfred L. Kroeber and Clyde K. M. Kluckhohn, *Culture: A Critical Review of Concepts and Definitions*, Papers of the Peabody Museum, Harvard University, v. 47, no. 12, pp. 643-4, 656 (Cambridge MA: The Peabody Museum, 1952).

4. Clifford Geertz, *The Interpretation of Cultures* (New York: Basic Books, 1973), p. 289. For more on the debate over the nature and meaning of culture see Adam Kuper, *Culture: The Anthropologists' Account* (Harvard University Press: Cambridge, MA, 1999). For debated differences between the concepts of culture and society a good starting point is Nigel Rapport and Joanna Overing, *Social and Cultural Anthropology: The Key Concepts* (Routledge: London and New York, 2000), entries on “culture” and “society”.

5. E. O. Wilson, *Consilience: The Unity of Knowledge* (Knopf: New York, 1998)

6. Glen Asner, this volume.

education. This means recognizing as viable subjects for historical analysis all individuals and social groups involved in space endeavors, regardless of their social standing. Martin Collins makes a similar point in the final paper in this volume, where he notes that Sputnik, and by extension other events in the history of spaceflight, was “a manifestation and symbol of deeper structures of economic and cultural order.” We would do well to ponder his call for “clarifying explanatory aims and tools—of placing spaceflight *in* history.”⁷

Despite the importance of the subject, very few systematic studies of the societal impact of space exploration have been undertaken over the last 50 years. One exception that stands out from four decades ago is *The Railroad and the Space Program: An Exploration of Historical Analogy*. Funded by NASA through the American Academy of Arts and Sciences, *The Railroad and the Space Program* focused on the uses of historical analogy to illuminate the problem of societal impact. Confident in the use of historical analogy as suggestive, but not predictive, of the future, the authors of the volume elaborated on two technological events whose beginnings were separated in time by 150 years. The railroad was, they said, an engine of social revolution that had its greatest impact only 50 years after the start of the railways in America. As a transportation system, the railway had to be competitive with canals and turnpikes and, 20 years after the start of railways in America, more miles of canals were being built than railroads. It was not at all clear that railroads could be economically feasible. However, though many technological, economic and managerial hurdles needed to be overcome, railroads are still with us. In the course of the nineteenth century they represented human conquest of natural obstacles, with consequences for humans’ view of nature and our place in it. Moreover, secondary consequences often turned out to have greater societal impact than the supposed primary purposes for which they were built.

The space program has had, and still has, its technological challenges, and the economic benefits may be even longer-term than those of the railroad. But by conquering the third dimension of space, as aviation did to a very small extent in the thin skin of Earth’s atmosphere and as the railroad did in two geographical dimensions, in the long run the space program may have an impact that exceeds that of the railroad. Although originally suspicious of parallels with the past, present, and future, the authors in the end saw “the possibility of moving up onto a level of abstraction where the terrain of the past is suggestive of the topography of the present and its future projection.”⁸ They cautioned that in taking such an approach, as much empirical detail

7. Martin Collins, this volume.

8. Bruce Mazlish (ed). *The Railroad and the Space Program: An Exploration in Historical Analogy*. (Cambridge, MA: MIT Press, 1965).

should be used as possible and analogies drawn from vague generalities should be avoided. Four decades later, *The Railroad and the Space Program* still makes for relevant reading.

In addition to that early study, there have been sporadic forays. On the occasion of the 60th anniversary of the British Interplanetary Society, NASA was heavily involved in a special issue of its journal devoted to “the impact of space on culture.”⁹ There NASA scientists Charles Elachi (now Director of the Jet Propulsion Laboratory) and W. I. McLaughlin, as well as historian Sylvia Kraemer, among others, discussed the impact of space endeavors on space science, politics, the fine arts, and education. In 1994 the Mission from Planet Earth program in the Office of Space Science at NASA sponsored a symposium entitled “What is the Value of Space Exploration?” A variety of speakers ranging from Carl Sagan to Stephen Jay Gould discussed the scientific, economic, cultural, and educational impact of space exploration.¹⁰

More recently, in 2005 the International Academy of Astronautics (IAA), which has a commission devoted to space and society, sponsored the first international conference on space and society in Budapest, Hungary.¹¹ The IAA and the European Space Agency (ESA) jointly sponsored a study published as *The Impact of Space Activities upon Society*,¹² in which well-known players on the world scene briefly discussed their ideas of societal impact, ranging from the practical to the inspirational.

In addition to these activities, the authors of more general studies of spaceflight have on occasion tackled the subject of societal impact. In her book *Rocket Dreams: How the Space Age Shaped Our Vision of a World Beyond*, Marina Benjamin argues that space exploration has shaped our worldviews in more ways than one. “The impact of seeing the Earth from space focused our energies on the home planet in unprecedented ways, dramatically affecting our relationship to the natural world and our appreciation of the greater community of mankind, and prompting a revolution in our understanding of the Earth as a living system,” she wrote. Benjamin thinks it no coincidence that the first Earth Day on 20 April 1970 occurred in the midst of the Apollo program; or that one of the astronauts developed a new school of spiritualism while others have also been profoundly affected spiritually; or that people

9. British Interplanetary Society, “The Impact of Space on Culture,” *Journal of the British Interplanetary Society*, 1993; 46(11).

10. NASA. What is the value of space exploration? July 18–19, 1994, NASA History Reference Collection.

11. IAA, 2005. Meeting agenda at <http://www.iaaweb.org/iaa/Publications/budapest2005fp.pdf>

12. European Space Agency, *The Impact of Space Activities upon Society*, ESA BR-237, 2005.

“should be drawn to an innovative model for the domestic economy sprung free from the American space program by NASA administrator James Webb.” Space exploration shapes world views and changes cultures in unexpected ways; by corollary, so does lack of exploration.¹³

Others have demonstrated the complex relation of space goals to social, racial, and political themes (see Kim McQuaid in this volume). One such study is De Witt Kilgore’s *Astrofuturism: Science, Race and Visions of Utopia in Space*, where the author examines the work of Wernher von Braun, Willy Ley, Robert Heinlein, Arthur C. Clarke, Gentry Lee, Gerard O’Neill, and Ben Bova, among others, in what he calls the tradition of American astrofuturism.¹⁴

Finally, we fully recognize that this volume is centered on Western culture and especially the United States. And although Western space programs may have had worldwide effects by their very scope and nature, we consider this analysis only a beginning and hope it will generate more robust discussion and comparison with the impact of space programs in other parts of the world. It also needs to be said that this conference and this volume were decidedly not designed as commercials for NASA or spaceflight in general. As scholars, our goal is not propaganda, but to use rigorous scholarly methods to examine societal impact. Only then can we begin to hope to measure the real impact of spaceflight.

In closing, we wish to thank our organizing committee, which included the staff of the NASA History Division (Glen Asner, Nadine Andreassen, Colin Fries, Stephen Garber, John Hargenrader, and Jane Odom), Roger Launius and his staff at the Smithsonian National Air and Space Museum (NASM), Linda Billings, Giny Cheong, John Cloud (National Oceanic and Atmospheric Administration [NOAA]) and a variety of others from whom we sought advice. We thank Scott Pace, NASA Associate Administrator for Program Analysis and Evaluation; Donald Lopez, NASM Deputy Director; and Ted Maxwell, NASM Associate Director for Collections and Research, all of whom gave opening remarks at the meeting. Our thanks also to our session chairs: William Becker (George Washington University),

13. Marina Benjamin, *Rocket Dreams: How the Space Age Shaped our Vision of a World Beyond* (Free Press: New York, 2003).

14. De Witt Douglas Kilgore, *Astrofuturism: Science, Race and Visions of Utopia in Space* (University of Pennsylvania Press: Philadelphia, 2003).

Dwayne Day (National Research Council), Cathy Lewis (NASM), Michael Ciancone (NASA Johnson Space Center), and William Sims Bainbridge (National Science Foundation). Our thanks to NASA's Printing and Design office for seeing this volume through the press. And finally, our thanks to the Smithsonian Institution's Hirshhorn Museum, which provided an appropriately artistic and congenial venue for the meeting.

Steven J. Dick, NASA Chief Historian
Roger D. Launius, National Air and Space Museum

Washington, DC December 2007

