PIONEERS IN EARLY SPACEFLIGHT

The Last of NASA's Original Pilot Astronauts

Expanding the Space Frontier in the Late Sixties

David J. Shayler & Colin Burgess

Springer

PRAXIS

The Last of NASA's Original Pilot Astronauts

Expanding the Space Frontier in the Late Sixties

David J. Shayler and Colin Burgess

The Last of NASA's Original Pilot Astronauts

Expanding the Space Frontier in the Late Sixties

Springer

Published in association with
Praxis Publishing
Chichester, UK

PRAXIS

David J. Shayler, F.B.I.S
Astronautical Historian
Astro Info Service Ltd
Halesowen
West Midlands
UK

Colin Burgess
Bangor
New South Wales
Australia

SPRINGER-PRAXIS BOOKS IN SPACE EXPLORATION

Springer Praxis Books
ISBN 978-3-319-51012-5 ISBN 978-3-319-51014-9 (eBook)
DOI 10.1007/978-3-319-51014-9

Library of Congress Control Number: 2017934482

Front: Escorted by Chief Astronaut John W. Young (in the blue flight suit), the prime crew for STS-4, Commander Ken Mattingly II, (foreground) and Pilot Henry 'Hank' Hartsfield Jr., walk out of the crew quarters at the Kennedy Space Center, Florida, to the astronaut transfer van taking them to *Columbia* on the launch pad.

Back LH: Group 5 astronaut Jack Lousma, Pilot Skylab 3, conducts an EVA during the 59-day mission in 1973.

Back RH: On the middeck of *Columbia*, Group 7 astronaut Bob Crippen, Pilot STS-1, takes a moment to enjoy his first space flight in 1981.

Cover design: Jim Wilkie
Project Editor: Michael D. Shayler

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Contents

Authors' Preface

This book represents the final chapter in the series of Springer-Praxis titles covering the early NASA Astronaut selections between April 9, 1959 and August 14, 1969, as listed in the Bibliography. Between these dates, 73 men were chosen to crew and support America's pioneering manned space missions under the Mercury, Gemini and Apollo programs. Several of them remained active long enough to crew missions in the first decade of Shuttle flight operations between 1981 and 1990. This current work focuses upon the selection, training and assignments of the final two purely pilot selections of the 1960s. NASA would not choose another astronaut group until the late 1970s and by then, a new set of criteria and objectives placed very different demands on the Astronaut Office than those of the decade before. Though mentioned in this title, detailed accounts of the missions flown by astronauts from the two selections are covered elsewhere and in companion volumes of the Springer-Praxis series, as detailed in the Bibliography. As this book was being researched and written, new information was released on the previously classified selections for the USAF MOL program (1963-1969). Although completely separate to the civilian NASA program, there were comparisons and links between the selection processes, and though this book is not a history of MOL, some information pertaining to the selection and training of MOL astronauts has been included for completeness.

Colin Burgess

Curiously enough, this new collaborative effort between Dave Shayler and I never began life as part of a series on the selection of NASA's astronauts prior to the Space Shuttle era. It had its origins in a friendship going back many years, a shared interest in the history of human space exploration – and in recording that history. I cannot recall who first mooted the idea (probably Dave), several years ago, of combining our talents and research to put together a book on NASA's 4th and 6th astronaut groups, known collectively as the scientist astronauts, but we found we worked well together, even though we happen to live on opposite sides of the globe. The result, published in 2007, was our first co-authored book for Springer-Praxis, *NASA's Scientist-Astronauts*.

And there it might have ended, but for a meeting we had in a restaurant one day when I was visiting England. During our conversation, we discussed the selection of the space agency's very first astronauts for the Mercury program. To our shared frustration, the names of five candidates for that role had eluded both of us for many years. Then, in a remarkable stroke of good fortune, I was contacted by a former military man, Walter ("Sully") Sullivan, who had acted as the liaison officer for the 32 Mercury astronaut finalists back in 1959 at Wright-Patterson Air Force Base, Ohio. He kindly offered to assist me if I wanted to write a book about this selection group. I agreed, and he subsequently sent me the names of the missing five candidates. Sadly, he is no longer with us, but with Sully working as a contact liaison and guarantor for me, I managed to locate all the Mercury candidates, or their surviving family members, and the result was the 2011 book, *Selecting the Mercury Seven: The Search for America's First Astronauts*.

I had no plans at the time to put together a follow-on book delving into the selection of the second NASA astronaut group. That is until Dave contacted me in a message filled with excitement, saying that in his latest search of NASA's treasure trove of historical records, he had unearthed documents giving the names of all the finalists for the second and third astronaut groups. With his own research for several books meaning he could not even look at this new project, he kindly offered those lists to me, and a whole new (and successful) hunt for these men or their family members began, culminating in a 2013 book on both groups for Springer-Praxis called *Moon Bound: Choosing and Preparing NASA's Lunar Astronauts*.

That same year, with the selection of NASA groups 1, 2, 3, 4 and 6 now covered in books, Dave and I began discussing the possibility of combining resources once again to produce another book detailing the process of choosing astronauts who became part of the two remaining pre-Shuttle classes: NASA Groups 5 and 7 (the latter also known as the MOL group). A contract was signed, and work began, albeit slowly at first. As we were both engaged in putting together other contracted books for Springer-Praxis over the next couple of years, our research and writing was necessarily spasmodic, but began to pick up steam once those other obligations had been cleared.

Both of us have interviewed several astronauts from Groups 5 and 7 to record their recollections and opinions, particularly the latter group of seven military test pilots who had formerly served and trained for the clandestine Manned Orbiting Laboratory (MOL) program before being transferred across to the civilian NASA space agency following the cancellation of MOL. While they arrived in the middle of Project Apollo and assisted in support crews and as capsule communicators (Capcoms) for the last few Apollo lunar missions – and later Skylab – none of the seven would fly into space until the Space Shuttle program began in 1981, some 12 years after they had joined NASA's astronaut cadre. Combine their stories with those of the largest astronaut group (19 in total) selected by NASA to that time and there are some truly riveting and intriguing tales to be told.

As the Chinese philosopher, Lao Tzu (better known as Confucius) once wrote: "A journey of a thousand miles begins with a single step," and the same applies to any book; it is usually sparked by a conversation or a suggestion made by a friend or space colleague. The only trick is in recognizing and acting on that suggestion, and I am delighted that Dave Shayler and I decided to act and take that first step together all those years ago. With the completion of this book, we feel we have finally recorded, separately and in partnership, the selection of seven groups of amazingly talented and bold men who pioneered

America's dynamic space program before the advent of the reusable Space Shuttle. I know we are both proud to have been able to record their stories, and to pass them on through their words and ours for hopefully many generations to come.

David Shayler

While following the first Apollo missions in 1968 and 1969, I began to learn more about the men who had been chosen for NASA astronaut training in the spring of 1966. These men had yet to fly in space, indeed several would not do so for many years, but they worked tirelessly on the ground, supporting the flights which culminated in the landings on the Moon by the crews of Apollo 11 and 12. It was during those magical months of 1969 that I also learned of future plans for Apollo; there were to be eight more landings before Apollo hardware would be used to orbit the first of a series of Orbital Workshops.

NASA would then return to the Moon, using adapted Apollo hardware for extended missions designed to create a lunar research station. These missions, I learned, could be crewed by astronauts of the 1966 selection, together with scientists from the groups chosen in 1965 and 1967. Shortly after the Apollo 11 mission, NASA transferred seven astronauts from the cancelled MOL program, adding to the pool of available astronauts for such bold plans. For an enthusiastic 14-year-old space fan, the new decade looked promising, and when the crews for Apollo 13 and 14 were named, members of the 1966 selection were included. It was pleasing to see some of the more recently selected astronauts finally get their chance to fly in space.

However, 1970 proved to be a low year for space exploration, with Apollo 13's explosion and abandoned lunar landing, but the safe return of the crew. Shortly afterwards came the cancellation of three Apollo lunar missions and rumors of not flying the second or third orbital workshop, now called Skylab. Sadly, I filed away, for what became nearly 30 years, the cuttings and reports on those plans and abandoned missions that Apollo might have achieved. With the final four Apollo missions, Skylab and the joint Apollo-Soyuz (ASTP) mission with the Soviets, there was still plenty for a budding space historian to follow and research, but then came the long wait between ASTP and STS-1. In those six years, I had gathered a useful reference archive on the NASA missions, astronauts and plans for the Space Shuttle. I had also become fascinated by what astronauts did in between training for, or flying, missions. These activities did not attract the coverage I would have liked, so I started my own research into these topics, together with gathering data on Skylab and the abandoned plans for Apollo.

Little did I realize that, some thirty years later, this early research would generate several book titles following the career paths of astronauts who were closely linked to both stories. Communications from former astronauts are among the prized possessions in my collection. Letters, interviews and emails, over many years, with astronauts Ed Gibson, Owen Garriott, Vance Brand, Jerry Carr, Jack Lousma, Bill Pogue, PJ Weitz, Tony England, Karl Henize, Bill Thornton, Bob Crippen, Story Musgrave and Joe Allen have provided an insight into the workings of the Astronaut Office, the era during which they were at NASA, and the missions on which they flew.

For me, it is important to ensure that the information presented within my books is as accurate and detailed as it can be. That I have portrayed a fair interpretation of what I have been told or have researched. If those who fly the missions are happy with my work, it is a job well done. Sometimes, the results of this research are quickly received, sometimes not, and occasionally a project from conception to publication can take a while. In the case of Jerry Carr's authorized biography *Around the World in 84 Days*, that 'journey' took 20 years from suggestion of the idea in 1988 to the publication of the book in 2008. This current project is, as Colin has mentioned, a similar 'expedition', over several years of cooperative work and built upon decades of personal research.

In this book, we have tried to blend the various stories, facts and background of those who were selected to NASA's astronaut program in 1966 and in 1969. We have also included stories from those who came very close to selection to that program. What this book could not include within the confines of a single volume are in-depth biographical accounts of each member of those two astronaut groups; nor could it offer detailed accounts of each of their missions. What this project presents, however, is a detailed overview of the backgrounds, selection, training and assignments of each group, and what happened to each of them when they finally hung up their spacesuits. Though this book is by no means the complete picture, we believe we have placed an important piece in the puzzle from which further research and publications are encouraged to add more color and depth to the overall story. This has been a long and very personal journey for both authors, and a project close to our hearts. We hope you enjoy the accounts in these pages as much as we have in creating it.

David J. Shayler, FBIS
Director, Astro Info Service Ltd
www.astroinfoservice.co.uk
Halesowen, West Midlands, England

Colin Burgess
Bangor
New South Wales, Australia

December 2016

Acknowledgements

Assembling a volume such as this requires access to a wealth of documentation, previously published works, and contact with key players in the story. It also depends upon *a lot* of personal research, which usually raises more questions than answers. The fulfilment of those queries depends upon a network of valued contacts across the world to finally piece together the account you read here.

In this particular case, the authors wish to thank the generous help, guidance and support of former members of the 1966 and 1969 NASA astronaut selections over many years, namely Vance Brand, Jerry Carr, Bob Crippen, Charles Duke, Fred Haise, Don Lind, Jack Lousma, Bruce McCandless, the late Bill Pogue, Richard Truly, Paul Weitz and Al Worden. We are also indebted to Fred Haise and Bob Crippen and to Vance Brand for their contributions in opening and closing the story we wished to tell.

Thanks also go to former NASA astronauts Tony England, Ed Gibson, Steve Hawley, Story Musgrave and Bill Thornton for their reminiscences of fallen colleagues Hank Hartsfield, Gordon Fullerton, Bob Overmyer and Bill Pogue.

The help and support of the following in the compilation of this book is also appreciated: Dave Anderson, Joachim Becker of *Spacefacts.de,* Scott Bull, Frank Ellis, Jack Ferrell, Francis French, Ed Hengeveld, Harry Swenson, Joseph Totah, Donald Watson, and Barbra Zuanich-Friedman.

Over a period of thirty years, the various staff and offices of the NASA History Department and Public Affairs Offices in Washington and Houston have been of immense help and support. Notable mention is made to NASA History Office staff Lee Saegesser, Roger Launius and Bill Barry (NASA Headquarters), and Janet Kovacevich, Joey Pellerin, David Portree and Glenn Swanson (NASA JSC). In the PAO at JSC, Houston, thanks go to Iva 'Scotty' Scott, Barbara Schwartz, Jeff Carr, James Hartsfield, and Eileen Hawley; from the Still Photo Branch, Mike Gentry, Liza Vaquez and Jody Russell; and from the Audio Library, Diana Ormsbee. From KSC, thanks go to Kay Grinter, and Margaret Persinger. From the NASA History Collection, at Clear Lake University, thanks to Shelly Kelly, and for access to the Curt Michel Collection at Rice University, thanks to Joan Ferry.

The authors wish to express their gratitude to American researcher and author Michael Cassutt, who unselfishly devoted his time and opened his files to enhance the content of this book. His support greatly enriched the overall story of the two astronaut groups and the background to the workings of the Astronaut Office during the 1960s to 1990s.

Thanks are also due to British space historian and author Dr. David Baker, for his insight into the broader picture of the U.S. space program in the 1960s and 1970s.

Once again, the staff and resources of the British Interplanetary Society in London proved invaluable in adding those little extra details to the account. The authors are grateful to former and current BIS staff members, notably Suzann Parry and Gill Norman, together with Ben Jones and Mary Todd.

The majority of the images used in this book originate from NASA, various military service organizations and the authors' own collections, unless otherwise specifically stated. However, despite extensive searches we have been unable to determine the origins of some of the images. The authors would welcome any input to enable us to credit the appropriate sources.

Our thanks must be extended, on the production side, to Clive Horwood at Praxis in England for supporting the project through the proposal stages, and Maury Solomon at Springer, New York. Once again, Jim Wilkie turned our original ideas for a cover into the finished product with skill and expertise, and an eye for detail.

Over many years of writing numerous books, individually and in collaboration, both of us know all too well the value of an astute and erudite editor, whose experience, diligence and expertise can transform any rough-hewn manuscript into a far more polished and presentable publication. We are therefore indebted to Mike Shayler, who took on the task of working on this book and did a truly superb job, right through to the production process. We thank him for his patience, persistence and good humor, and agree that he consistently proves the enduring power of a skilled and subject-knowledgeable copy editor.

Both authors also wish to express our love and appreciation to our wives, Bel Shayler and Pat Burgess, and our families for, once again, allowing us to indulge in the challenge of turning an idea discussed over a good beer into what you see here.

To everyone who helped on this final project in the series of titles, by both authors, on the first decade of NASA Astronaut Selections, a very large Thank You.

Foreword

This is the story of two remarkable groups of pilots who were considered for very different American human space programs. Many made it into space, some did not. A few journeyed to the Moon, others returned to orbit several times. They all came from very different aviation backgrounds, but their individual stories were entwined when budget restrictions affected both programs and the fates of all involved. The varied paths to space for these two selections are recalled in the following comments from the first of each group to finally reach orbit.

Fred W. Haise, NASA Class of 1966, became, in April 1970 as LMP on Apollo 13, together with the late Jack Swigert as CMP, the first of their selection to fly in space.

My entry into the Astronaut Office as a member of the "Original 19" group, chosen in 1966, was carried out with some reluctance, leaving the best flying job that I ever had at the NASA Dryden Flight Research Center (now Armstrong Flight Research Center), at Edwards Air Force Base, California. I had followed Neil Armstrong in a NASA career path through the Lewis Research Center (now Glenn Research Center) and into the astronaut program. I followed Neil by about 2½ years. Being a NASA employee, it was just another transfer, with the same GS civil service pay grade and title as an Aerospace Research Pilot & Engineer. There was no "Astronaut" position title on the civil service registry at that time.

While at the Dryden Flight Research Center, I'd hoped to fly the X-15 rocket ship, like Neil Armstrong, but such an assignment was clearly based on seniority within that office. When I left Dryden to join NASA's astronaut program, I was still two people away from having my turn at flying the X-15. As it turned out, I made the right decision in leaving the Center, as the X-15 program ended before I would have had a chance to fly.

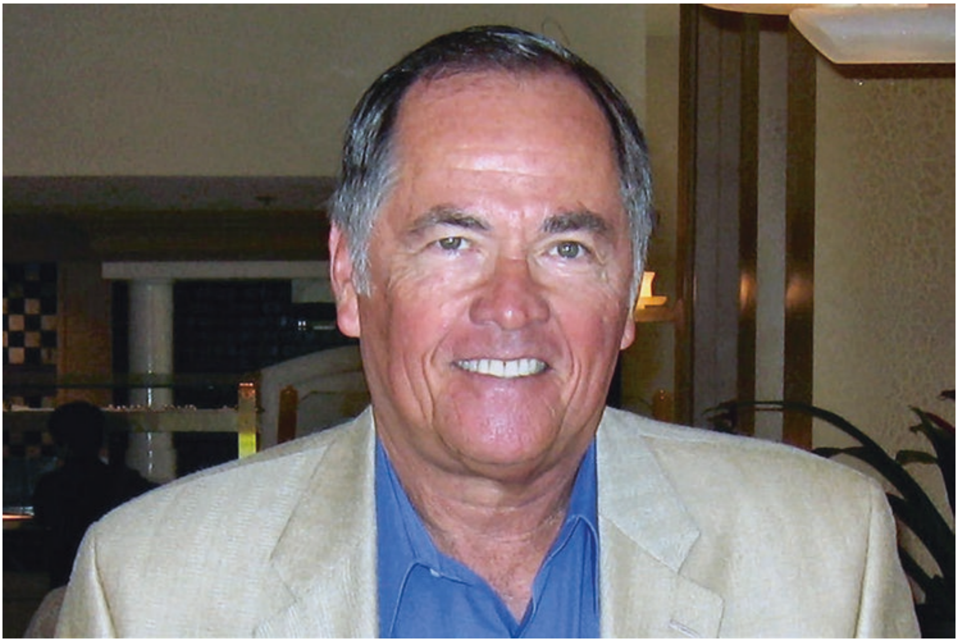
I'd been working at NASA before, so for me it was just another transfer from one NASA center to another. I knew that the astronaut day-to-day activity consisted of lots of time in meetings and training, with actual flying being conducted mostly for travel to contractor facilities, other NASA centers, and so forth. But the thought of possibly flying a lunar mission was the reason that I applied.

Ed Mitchell, as the oldest and most senior, became the designated leader for our "Original 19". Once we'd settled in and completed our training, we received initial assignments related to our particular area of specialty, and everyone in our group just went to the winds during this early part of Apollo.

When I arrived at NASA, I didn't think of myself as a person of particular renown at the time; I was just a test pilot. But, in the way these things go, I arrived at the right time, with the right experience and the right background for Apollo. I feel lucky to have had the chance.

Fred W. Haise,
NASA Astronaut (1966–1979)
Lunar Module Pilot Apollo 13
Commander ALT Crew 1 (OV-101 Enterprise)
Commander OFT-3 (1978–1979)

Fred W. Haise



Robert L. Crippen (Courtesy Robert L. Crippen)

Robert L. Crippen, NASA Class of 1969, was one of the former MOL astronauts who transferred to NASA shortly after the first lunar landing. In April 1981, as Pilot on STS-1, he became the first of his selection to reach orbit, and just over a decade later became the first former astronaut to direct a NASA field center.

In 1965, I was a Naval Aviator attending the Air Force test pilot school, renamed as the Aerospace Research Pilot School (ARPS). That year, both NASA and the Department of Defense (DOD) put out an announcement for Astronaut applications. Like almost every student I submitted my application. I took the option of submitting my name for both programs.

Later in the evaluation process, the Navy informed me that I was still in the running, but I would have to choose between NASA and DOD. That year, DOD had named the first group to a new program called the Manned Orbiting Laboratory (MOL). I thought that NASA had plenty of Astronauts and my best chance was with the MOL Program. Plus, I thought the idea of military Astronauts was a good one. Out of that selection process, I was lucky enough to be one of the five who was selected for MOL. The NASA process selected nineteen in their Astronaut Group 5; many were my contemporaries from ARPS.

However, on what was one of the low points of my life, June 10, 1969, the MOL Program was cancelled. There had been a third MOL selection which had added four more crew members. With a death and some crew departures, we were down to fourteen Astronauts at the time of cancellation.

After several days of wondering what the future would bring for us, Karol (Bo) Bobko, one of the fourteen, asked if NASA would take us into the Astronaut Office. The rest of us thought that wasn't going to happen. We hadn't got to the Moon yet and some of the planned flights were already being cancelled. That meant NASA already had too many Astronauts. Still, the question was asked and we were all invited to Houston's Manned Spacecraft Center (MSC), now JSC, for interviews.

We arrived during the Apollo 11 flight. Deke Slayton, head of Flight Crew Operations, talked to us. He told us what we had expected to hear. They didn't need any more Astronauts. However, one of the big bosses at NASA Headquarters, George Mueller, told Deke that he had to take some of us. Deke decided to take all who were 35 and under. That was the age NASA used in the selection process. It split the fourteen in half. Seven of us, including myself, were reassigned to the NASA Astronaut Office. Deke was quite frank with us. He said that he didn't have any flights for us, but he had lots of work. He did mention that our first flight opportunity wouldn't probably be until a non-approved Program called the Shuttle came on line, and that wouldn't be before 1980. That still sounded like an opportunity to us. We became Astronaut Group 7.

That group played a major role in the development of the Space Shuttle when it was approved. All seven flew on the first six flights of the Shuttle.

This book will be a mandatory read, for those interested in the space program. It is about Groups 5 & 7 and the roles they played in the years following their selection and their participation in the space program.

Captain Robert L. ('Crip') Crippen, USN Retired.
USAF MOL Astronaut (1966-1969)
NASA Astronaut (1969-1992)
Pilot STS-1
Commander STS-7, STS-41C and STS-41G
Commander (planned), STS-62A (1984-1986)

This book is dedicated to all members
of the 1965, 1966, 1967 and 1969
MOL and NASA pilot astronaut classes

Especially to the memory of:

Michael J. Adams
John S. Bull
Ronald E. Evans
John L. Finley
Charles Gordon Fullerton
Edward G. Givens Jr.
Henry W. Hartsfield Jr.
Robert T. Herres
James B. Irwin
Robert H. Lawrence Jr.
Richard E. Lawyer
Robert F. Overmyer
William R. Pogue
Stuart A. Roosa
John L. Swigert Jr.
James M. Taylor

We also dedicate this work to those who came so close to selection but who, in the end, were unsuccessful in their personal quest for space. They, too, deserve to be recognized for their contribution to the program. Together with all the families who supported those who made it to space, and those who almost did; this is their story too.

This book is also dedicated to a true American legend; a man who inspired millions of people in his homeland and around the globe as a Mercury astronaut and the first American to orbit the Earth, and 36 years later was launched on a Space Shuttle mission. A man who served his nation as a Marine fighter pilot and U.S. Senator and continued to be an inspiration and role model throughout his life. Godspeed, John Glenn (1921-2016).

During the final preparation of this book, the authors also learned of the passing of Capt. Eugene A. ('Gene') Cernan (1934-2017), the NASA Group 3 astronaut who performed America's second spacewalk and travelled twice to the Moon, walking on its surface as commander of the Apollo 17 mission and earning the lifelong title of Last Man on the Moon in December 1972. A great man, sadly missed.

Abbreviations and Acronyms

Informal Military Designations

USAF:
"FS" stands for Fighter Squadron; "RS" for Reconnaissance Squadron; "BS" for Bomber Squadron

US Navy:
"V" stands for fixed wing; "F" for fighter wing; "A" for attack; "Q" for electronic; "R" stands for Reserve but can also stand for Reconnaissance; "W" for early Warning; "T" for training, "X" for test and evaluation (as in eXperimental)

USMC:
Marine air units use the suffix "M" within the US Naval designation coding, such as VMFA for fixed, with AW added for "All Weather" squadrons

2TV-1	CSM thermal vacuum chamber test vehicle
AAP	Apollo Applications Program (Skylab)
ACTS	Attitude Control and Stabilization System (MOL)
AFB	Air Force Base
AFTPS	Air Force Test Pilot School
AFFTPS	Air Force Flight Test Pilot School
AFIT	Air Force Institute of Technology
AFSC	Air Force Systems Command
AFSSC	Air Force Space Systems Command
ALSEP	Apollo Lunar Surface Experiment Package (Apollo 12–17)
ALT	Approach and Landing Tests (Space Shuttle)
AMU	Astronaut Maneuvering Unit (Gemini)
ANG	Air National Guard
AOCS	Aviation Officer Candidate School (USN)
ARPS	Aerospace Research Pilot School

AS	Apollo-Saturn
ASTP	Apollo Soyuz Test Project
ATDA	Augmented Target Docking Adapter (Gemini)
ATS	Acquisition and Tracking Scope (MOL)
AW	Air Wing
BOQ	Bachelor Officers Quarters
BSc	Bachelor of Science degree
BUp	Back Up (crewmember)
Capcom	Capsule Communicator (Mission Control)
CB	Astronaut Office, MSC/JSC (Mail Code)
CDR	Commander (Apollo/Skylab/ASTP & Space Shuttle)
CM	Command Module (Apollo)
CMP	Command Module Pilot (Apollo)
CO	Commanding Officer (DOD)
CSD	Crew Systems Division (MSC/JSC)
CSM	Command and Service Module (Apollo)
CSNR	Center for the Study of National Reconnaissance
DMP	Docking Module Pilot (ASTP)
DOD	Department of Defense
EAFB	Edwards Air Force Base (California)
EASEP	Early Apollo Science Experiment Package (Apollo 11 only)
EDCTU	Electronic Development Component Test Unit (MOL)
EDS	Engineering Development Simulator (MOL)
EO	Executive Officer (also known as XO)
EVA	Extra Vehicular Activity (spacewalk)
FD	Flight Director (Mission Control)
FCOD	Flight Crew Operations Directorate (MSC/JSC)
FOD	Flight Operations Directorate (MSC/JSC)
GBPS	Gemini B Procedures Simulator (MOL)
ISS	International Space Station
IVA	Intra Vehicular Activity
JSC	(Lyndon B.) Johnson Space Center (from 1973), Houston (Texas) (formerly MSC)
KIA	Killed in Action
KSC	(John F.) Kennedy Space Center (Florida)
KSU	Kansas State University
LC	Launch Complex
LCC	Launch Control Center (KSC, Florida)
LM	Laboratory Module (MOL)
LM	Lunar Module (Apollo)
LMP	Lunar Module Pilot (Apollo)
LMSE	Laboratory Module Simulation Equipment (MOL)
LEM	Lunar Excursion Module (early name for Apollo LM)
LLRV	Lunar Landing Research Facility (Langley Research Center, Virginia)
LLTV	Lunar Landing Training Vehicle (Apollo)

LRV	Lunar Roving Vehicle (Apollo 15–17)
LTA	Lunar (Module) Test Article
LTV	Ling-Temco-Vought
LVPS	Laboratory Vehicle Procedures Simulator (MOL)
MAW	Marine Air Wing
MCAS	Marine Corps Air Station
MCC	Mission Control Center (MSC/JSC, Houston, Texas)
MDS	Mission Development Simulator (MOL)
MET	Mobile Equipment Transporter (Apollo 14)
MIA	Missing In Action
MIT	Massachusetts Institute of Technology
MM	Mission Module (MOL)
MMP	Mission Module Pilot (AAP)
MMU	Manned Maneuvering Unit (Space Shuttle)
MOCR	Mission Operations Control Room (MSC/JSC)
MOL	Manned Orbiting Laboratory (USAF)
MPSE	Mission Payload Simulation Equipment (MOL)
MS	Mission Specialist (Space Shuttle)
MSc	Master of Science degree
MSC	Manned Spacecraft Center, Houston (Texas); from 1973 JSC
MSE	Manned Spaceflight Engineer (USAF, Space Shuttle)
MSFC	(George C.) Marshall Space Flight Center, Huntsville (Alabama)
NAAS	Naval Auxiliary Air Station
NAPS	Naval Academy Preparatory School
NAS	Naval Air Station
NASA	National Aeronautics and Space Administration
NRO	National Reconnaissance Office
OFT	Orbital Flight Test (Space Shuttle)
OV	Orbital Vehicle (Space Shuttle)
OWS	Orbital Work Shop (AAP/Skylab)
PhD	Doctorate degree
PLSS	Portable Life Support System
PLT	Pilot (Skylab; Space Shuttle)
POW	Prisoner Of War
PS	Payload Specialist (Space Shuttle)
PSAC	President's Science Advisory Committee
RADM	Rear Admiral
RIO	Radio Intercept Officer
RMS	Remote Manipulator System (Space Shuttle)
ROTC	Reserve Officer Training Corps
SA	Saturn-Apollo
SAC	Strategic Air Command (USAF)
SAIC	Science Applications International Corporation
SAS	Space Adaption Syndrome
ScPLT	Science Pilot (Skylab)

SDIO	Strategic Defense Initiative Organization
SESL	Space Environment Simulation Laboratory
SETP	Society of Experimental Test Pilots
SIM	Scientific Instrument Module (Apollo)
S-IVB	Saturn 1B second stage; Saturn V third stage, Skylab converted into OWS
SL	Skylab
SLM	Simulated Laboratory Module (MOL)
SM	Service Module (Apollo)
SMEAT	Skylab Medical Experiment Altitude Test
SPS	Service Propulsion Systems (Apollo)
STOL	Short Take Off & Landing
STS	Space Transportation System (Space Shuttle)
TPS	Test Pilot School
UCLA	University of California at Los Angeles
USAF	United States Air Force
USAFA	United States Air Force Academy
USC	University of Southern California
USMA	United States Military Academy (West Point)
USMC	United States Marine Corps
USN	United States Navy
USNA	United States Naval Academy (Annapolis)
USSR	Union of Soviet Socialist Republics (1917–1991) now Russia
VAB	Vehicle Assembly Building (KSC, Florida)
XO	Executive Officer (also known as EO)

Prologue

It was a Monday afternoon that should have been filled with optimism and a tantalizing glimpse into an exciting future. Instead, Maj. Jack Lousma of the U.S. Marine Corps sat quietly in a sparsely-furnished waiting room, contemplating the calendar on the opposite wall and the decision that had brought him to this renowned space center in Houston. For him, on the eve of his leap-year birthday, it was a day filled with a terrible irony. The date he noted on the calendar was the 28th – the last day of February 1965 – and he was one of several test pilots, many of them known to him, who were now undergoing daunting and extensive interviews with a panel of real astronauts at NASA's Manned Spacecraft Center.

A reconnaissance and attack pilot with the 2nd Marine Air Wing based at Cherry Point, North Carolina, Lousma had taken up the challenge of applying for the role of pilot astronaut, after NASA had announced it was seeking suitably-qualified candidates for a fifth intake of men who would one day – they hoped – fly into space. Just a month earlier, they had undergone a battery of thorough physical examinations at the School of Aviation Medicine in San Antonio, and now he faced this final, crucial hurdle in the selection process.

On that day, however, he and a number of other candidates were coping with the shocking news that the prime crew for the upcoming Gemini IX mission, astronauts Elliot See and Charlie Bassett, had been killed only hours before. Their T-38 jet had encountered filthy, blinding weather on approach to Lambert Field in St. Louis, Missouri, and had slammed into the roof of the McDonnell plant where their spacecraft was being readied, before plummeting into a nearby car park and exploding. It was sobering news for the 29-year-old Marine Corps officer. Like so many other combat and test pilots, Lousma had become somewhat inured to hearing of fellow officers being killed, but now he was wondering how his wife Gratia would receive the tragic news, and if she would still support his astronaut application. It was a time for serious contemplation, but he shook off any doubts and accepted that, if successful, he would undoubtedly be entering into yet another highly dangerous occupation. He resolved to press ahead regardless, become an astronaut, and one day fly into space – perhaps even on a journey to the Moon.

Less than two months later, on April 4, 1966, Maj. Jack Lousma and 18 other men were officially announced as members of NASA's latest cadre of astronauts – Group 5 officially, but (in homage to the earlier Mercury astronauts) they also came to be wryly known as the "Original Nineteen."

…………………………………………………..

On the first day of 1958, nine months before civilian space agency NASA became operational, the U.S. Air Force established a bold program to develop a winged vehicle capable of placing specially-selected and trained USAF pilots into Earth orbit, where they would link up with and enter a station already circling the globe. Their task would be to conduct covert reconnaissance and test operations, satellite maintenance, and perhaps even intercept and sabotage enemy satellites while orbiting aboard the station. All this and more before re-entering aboard an innovative space plane, equipped with retrorockets for the return journey. After retrofire, the pilot would control the re-entry glide at a precise descent angle through the atmosphere and touch down at Edwards Air Force Base on the all-skid landing gear, similar to that used by the X-15.

As with earlier programs, this USAF man-in-space project was given a contingency X designation, and was known thereafter as the X-20 program. Alternatively, it became known as Project Dyna Soar (a contraction of Dynamic Soaring), with the program based on the solid principle that an object can achieve extremely high altitudes through a combination of rocket propulsion and aerodynamic lift capability.

In November 1959, the Boeing Corporation was selected as the prime contractor for the design and construction of the Dyna Soar vehicle, which would be launched atop the (later selected) Titan III booster. Essentially, the heavily-insulated X-20 was to be fabricated from advanced metal alloys, including molybdenum, in order to combat the extreme heat of re-entry through the atmosphere. When compared to the later Space Shuttle, it was a relatively small vehicle. Only 45 feet long, it boasted tiny delta wings, a flat lower surface, twin vertical tail fins, and a blunt, rounded nose.

Although the X-20 development program continued, future funding became even more monumentally difficult by 1961, when Secretary of Defense Robert S. McNamara declined to give the Air Force any further financial backing for the project. Despite this setback, plans carried on as usual.

The need for highly-skilled pilots to man the X-20 had resulted in 10 active USAF and NASA test pilots undergoing secret physical examinations in August 1959, ready to train for the military missions that were expected to begin within four years. On April 1, 1960, seven prospective pilot-astronauts were secretly chosen for the program.

- Mr. Neil A. Armstrong (NASA)
- Mr. William H. 'Bill' Dana (NASA)
- Capt. Henry C. Gordon (Air Force)
- Capt. William J. 'Pete' Knight (Air Force)
- Capt. Russell L. Rogers (Air Force)
- Mr. Milton O. 'Milt' Thompson (NASA) and
- Maj. James W. Wood (Air Force)

In the summer of 1962, Neil Armstrong and Bill Dana left the program and were replaced by USAF test pilot Capt. Albert H. Crews Jr. On September 19, 1962, Crews, Gordon, Knight, Rogers, Thompson and Wood (nominated as "pilot engineers") were announced to the public, with Air Force General Bernard A. Schriever presiding. Along with the announcement came a public unveiling of a full-size wooden mock-up of the space plane. The six began training at Edwards and Wright-Patterson AFBs, but the program – already slowed by budget cuts and developmental problems, and well behind schedule – would never achieve operational status. On December 10, 1963, Robert McNamara officially cancelled the X-20 Dyna Soar program.

In the meantime, and since 1960, the Air Force had been conducting feasibility studies into the development of a highly-classified manned military space station program. On December 10, 1963, the same day as the official cancellation of the X-20 program, Robert McNamara announced that the U.S. Air Force had been assigned to the development of an Earth-orbiting space "laboratory." The first of these USAF stations was scheduled to be placed into polar orbit by a Titan IIIM space booster sometime in 1971, providing a shirt-sleeve environment in which two military astronauts could live and work for a planned 10-day period, using a Gemini-style spacecraft as their launch and re-entry vehicle. However, specific details of the role the laboratory and astronauts would play were withheld from the public, as it was always planned to be a functioning spy platform in space, with sophisticated cameras and other surveillance equipment included. This Cold War program was to be given the unpretentious name of Manned Orbiting Laboratory, better known by the brief acronym MOL. Shrouded in secrecy for decades, it would also be given the later tag of "Blue Gemini."

In issuing a call for prospective MOL pilots, the USAF set out some basic qualifications. The applicant had to be a U.S. citizen, no more than six feet tall, born after December 1, 1931, and a graduate of a service academy – or have achieved a bachelor's degree in engineering, natural science, physical science, or biological science. In addition, the applicant had to have passed the appropriate military physical examination. No civilians were permitted to apply. As it turned out, all 17 officers later selected in three groups (eight in November 1965, five in June 1966 and four more in June 1967) were graduates of the Aerospace Research Pilot School (ARPS) at Edwards AFB, California. Upon selection, they were immediately dispatched back to the ARPS for advanced training specifically designed for their new assignment. This included special courses in advanced astrodynamics and many hours spent flying simulated spaceflight profiles.

The genesis of the ARPS can be traced back to 1959. With several military and civilian space programs on the drawing board, it was determined that some crucial changes needed to be made to the curriculum at the U.S. Air Force Test Pilot School at Edwards AFB. The X-15 rocket plane was already undergoing flight performance testing at Edwards and it became apparent that the USAF would soon have a need for a dedicated manned spaceflight operation. That year, future NASA Group 5 astronaut Capt. Edward Givens and his civilian instructor colleague, William Schweickhard, took the concept of a full aerospace course to the school's commandant, Maj. Richard Lathrop. After much deliberation, he decided there was considerable merit in the idea and in turn asked his special assistant Maj. Thomas McElmurry to get the project up and running.

On June 5, 1961, the proposal became a reality, with an initial Class I comprising five student aerospace pilots, all graduates of the Test Pilot School. On October 12 that year, the Experimental Flight Test Pilot School was officially redesignated the USAF Aerospace Research Pilot School, or ARPS, which was designed to help Air Force pilots gain the qualifications to become astronauts, or USAF astronaut-designees as they became known.

The second ARPS class was announced on April 20, 1962, and the eight nominated pilots began their studies two months later. Several of the graduates from the ARPS classes would subsequently become involved in projects such as the X-15, X-20 and Lifting Body program, while many went on to become NASA astronauts.

On October 22, 1962, while NASA was concentrating its efforts on Project Gemini, the third ARPS class was selected, comprising 11 Air Force officers. This class received specific X-20 (Dyna Soar) training as part of their course. The fourth and final ARPS class began in May 1963, made up of fourteen USAF officers and a solitary representative each from the U.S. Navy and U.S. Marine Corps.

Eventually, however, the 17 officers destined for MOL who underwent extensive training through the ARPS were in for a severe disappointment. When the development of MOL hardware began in 1965, the anticipated cost through to 1974 was an estimated $1.5 billion. Four years later, however, this had ballooned to double that amount. It was a perilous time for any technology-based program in the United States, given the inflationary increase attached to the project and the mounting, massive cost of the war in Vietnam.

On June 10, 1969, after the MOL program had been under development for five-and-a-half years, it was abruptly cancelled. By this time, it had consumed over a billion dollars of a greatly-tightened U.S. defense budget.

…………………………………………………..

In the meantime, NASA was on a roll. In late 1965, following the unqualified success of Projects Mercury and Gemini to that time, and with planning for the first Apollo missions now well advanced, it was time to look beyond the Moon landings and initiate human space flight programs for the future. Accordingly, a new office was set up at the Manned Spacecraft Center (MSC) in Houston. This office was tasked with researching and developing a series of extended Apollo missions and the hardware that would be needed to carry them out. Several astronauts were assigned to assist in carrying out initial work studies.

Subsequently, on February 3, 1966, Alan Shepard – then Chief of the Astronaut Office – announced the creation of a new branch office, known as the Advanced Programs Office. In those days within NASA, things moved rapidly. Just seven weeks later, on March 23, NASA unveiled details of a new program for the future. It boldly forecast a total of 45 human-tended space missions, utilizing some 26 Saturn IB and 19 Saturn V launches in both Earth and lunar orbit phases of the program – all to take place by the mid-1970s. With the unglamorous title of Apollo Applications Program, or AAP, one facet of this audacious plan involved utilizing three Saturn S-IVB Spent Stage Experiment Support Modules, otherwise known as habitable "wet" orbital workshops, three Saturn-launched orbital laboratories, and four Apollo Telescope Mount missions. The first AAP launch – assuming all went well with the companion lunar landing program – was envisaged to take place in April 1968.

This impressive schedule gave a reassuring boost in confidence to the space agency's astronauts, who had earlier harbored concerns about a dire lack of seats on future space missions, particularly the scientist-astronaut brigade, and the soon-to-be-announced 19 members of NASA's Group 5 astronauts.

The ranks of NASA astronauts were swelled even more following the cancellation of the MOL program on June 10, 1969, just a month prior to the historic mission of Apollo 11. While there were calls for NASA to integrate these 14 trained pilots (two of the original 17 had since resigned and one had been killed) into the astronaut ranks, Director of Flight Crew Operations Deke Slayton argued that there were simply no flights for them, as he already had too many astronauts on the mission waiting list. Under pressure from above to take at least some of the men, Slayton worked out that half of them were still under the age limit that had been set for NASA's pilot-astronauts, and he agreed to take those seven on board. As it turned out, none of the seven transferred MOL astronauts would fly until the Space Shuttle program began in 1981, some 12 years later, although a few supported several missions.

This is the story of the Group 5 and Group 7 (MOL) astronauts, which will conclude both authors' cooperative books on the history of NASA's astronaut selection program prior to 1978, when 35 additional astronauts were chosen. That selection came about specifically to operate missions aboard the reusable winged Space Shuttle and the 1978 group would comprise pilots, engineers and scientists, and include the recruitment of women and minorities into the astronaut corps.

In the momentous decade between 1959 and 1969, NASA selected a total of 73 astronauts over seven groups of candidates. We trust that you will not only enjoy reading the story behind the selection of the Group 5 and 7 astronauts, but also learn a little about those who were ultimately chosen. It is a compelling (and now complete) history associated with the NASA space agency, during the most dynamic and enthralling period of the 20th Century.

1

The selections

"You can apply for NASA, you can apply for MOL,
and you can apply for both. But if you apply for both,
I guarantee you we are going to pick you for MOL
and not let NASA have y'all."
Buck Buchanan,
Deputy Commandant, USAF Test Pilot School,
Edwards AFB, California.
From Charles M. Duke, NASA Oral History, 1999.

During the middle years of the 1960s, over a period of 19 months, 36 American pilots were selected for the nation's human space program, divided almost equally between the 'civilian' NASA astronaut program and the classified 'military' Air Force space station program.

These men, together with those who had missed out in the final selection, were the cream of American aerospace in the mid-1960s. True, they were not the legends of Edwards Air Force Base; those with the 'Right Stuff' who challenged the limits of rocket planes and, usually, lived to tell the tale. Neither were they the vanguard of American manned spaceflight, the gladiators who had taken up the Soviet gauntlet and run the early race for the Moon. But these three dozen men would become the lynch-pin between those heady days of the early 1960s, when the 'new ocean' of space was still an unknown, and that of the new millennium, where eyes were once again looking to new goals even deeper in that 'ocean'.

On November 12, 1965, the USAF named the first class of eight pilots to train as astronauts for the military Manned Orbiting Laboratory (MOL) program. Less than six months later, on April 4, 1966, NASA announced 19 new astronauts to prepare for missions within the Apollo program. Two further Air Force announcements followed; on June 17, 1966 (five candidates) and a year later, on June 30, 1967 (four candidates), completing the selections for MOL astronauts. Within three years, members of the NASA Class of '66 were fulfilling assignments in support of the first Apollo missions and preparing for their own initial flights into space. Meanwhile, the group of MOL astronauts remained firmly on the ground, with the prospect of any flight still several years away.

D.J. Shayler, C. Burgess, *The Last of NASA's Original Pilot Astronauts*,
Springer Praxis Books, DOI 10.1007/978-3-319-51014-9_1

In June 1969, just a month prior to the Apollo 11 lunar landing mission, the MOL program was cancelled. A few weeks later in August, seven former MOL astronauts transferred to the NASA program, creating the seventh and final NASA astronaut class of the decade. It would be more than eight years before the next NASA astronaut class was named, chosen to support the emerging Space Shuttle program. It would be sixteen years from the cancellation of MOL before a serving military officer who had not been seconded to NASA finally reached orbit, as a Military Payload Specialist (officially known as a Manned Spaceflight Engineer, or MSE) on the Space Shuttle.

The path to space for any crewmember is strewn with danger, setbacks, disappointment, and personal sacrifice. The road to space for the MOL astronauts and members of NASA's Class of '66 was also a long and involved one, which began in the closing days of 1963 and ended 27 years later towards the end of 1990, as the last member of those selections completed their final flight into space.

SELECTING THE RIGHT MEN WITH THE "RIGHT STUFF"

Due to the secretive nature of the program, the announcements of the three groups of MOL astronauts in 1965, 1966 and 1967 gave little insight into the process of selecting the final candidates. Indeed, little was learned in the fifty years following the first selection, though some snippets of information did emerge over that time. It was not until the formal release of declassified MOL documents in October 2015 that the process could finally be pieced together, though some gaps in the story remained. The selection of the fifth NASA group – conducted in the same time frame as the second MOL selection – was different to previous selections, in that military applicants could apply for NASA, MOL, or both. For years, uncovering the identities of those who had reached the final stage but had not been selected has been a challenge, due in part to this military connection with MOL. Although each selection was devised to staff completely different programs, there were remarkable similarities between them. The former MOL astronauts who formed the NASA Class of '69, together with their colleagues from the Class of '66, fulfilled key positions during the later Apollo and early Shuttle years. In fact, pilot members from all the MOL and NASA selections chosen between November 1965 and June 1967 successfully attained significant positions both inside and outside of the space program, long after many had hung up their space boots.

Men for MOL

When the X-20 Dyna Soar program was officially cancelled in December 1963, the Manned Orbiting Laboratory was announced as its replacement. Though it still lacked formal program authorization, due to negotiations between Air Force Systems Command (AFSC) and the Pentagon, it soon became clear that the formal go-ahead was imminent and the selection of astronauts for the program would have to be instigated.

The process of choosing suitable personnel for classified programs was not new to the USAF, who used the X-20 model as a reference for choosing pilots. This process pre-dated the famous Aerospace Research Pilot School (ARPS) course at Edwards Air Force Base

(EAFB) in California, which was subsequently created to prepare suitably talented Air Force officers for future military space programs, such as the Blue Gemini.

The question of recruiting Air Force astronaut candidates was discussed by the commander of the AFSC, General Bernard Schriever and his staff, together with Colonel Chuck Yeager, the first Commandant of the ARPS[1]. Apparently, Yeager was upset following the 1963 NASA selection of USAF pilots who did not hold a test pilot qualification (including Edwin E. 'Buzz' Aldrin and William A. Anders) and had insisted that all future USAF astronauts should at least be graduates of ARPS[2]. Yeager had been in contact with Buck Buchanan, who was a graduate of the first ARPS Class and worked at the Pentagon in Washington, and had discussed this requirement. In early 1964, they took it upon themselves to decree that any astronauts chosen for MOL (or any other USAF manned space program for that matter) would be drawn exclusively from the ARPS program. To this end, they had conducted their own screening of potential candidates, settling on a list of 55 or 56 pilots, as well as members of Class 64A at Edwards who were scheduled to complete their course in December 1964.

From this group, 15 suitable candidates were identified, who were then informed of the possibility of their assignment to MOL.

In October 1964, at the Pentagon, a MOL astronaut selection board was appointed to evaluate each candidate and meet them face-to-face. Each of these candidates was then sent for a week of medical evaluations at Brooks AFB, San Antonio, Texas, between October 19 and 22, 1964. The 15 MOL candidates were:

Capt. Michael J. Adams, USAF (Test Pilot Class 62C, ARPS IV graduate)
Capt. Alfred L. Atwell, USAF (62A, ARPS III)
Capt. Robert S. Beale, USAF (63A)
Capt. Tommy I. Bell, USAF (59C, ARPS IV)
Capt. Albert H. Crews, Jr., USAF (60A, ARPS II)
Lt. John L. Finley, USN (64A)
Lt. Patrick Henry, Jr., USN (63A)
Capt. William J. Knight, USAF (58C, 63A)
Capt. Richard E. Lawyer, USAF (63A)
Capt. Lachlan Macleay, USAF (60A, ARPS IV)
Capt. Francis G. Neubeck, USAF (60C, ARPS III)
Capt. Alexander K. Rupp, USAF (62C, ARPS IV)
Capt. James M. Taylor, USAF (63A)
Capt. Gervasio Tonini, USAF, (64A) and
Lt. Richard H. Truly, USN (64A)

[1] Formerly the Air Force Flight Test Pilot School (AFFTPS).

[2] Yeager, one of the most famous test pilots in the world and the man who finally broke the sound barrier in the X-1 on October 14, 1947, had been educated only to high school level. Without a college degree, he was not eligible to apply for the NASA astronaut program. Ironically, many of the pilots he had trained did have a college education and were eligible.

Later that month, the selection board held meetings at Andrews AFB, Maryland, and at Systems Command Headquarters. Members of this board included Yeager and Buchanan, Lt. Gen. Richard Bohannon the Command Surgeon General of the USAF[3], and Maj. Gen. Osmond Ritlands, among others. After evaluating the results from the tests and interviews, the Board chose nine candidates to go forward. They were all personally informed of their selection by Yeager. The six who were disqualified, for reasons still unclear, were: Atwell, Beale, Bell, Henry, Tonini and either Knight or Rupp.

The nine were told of their selection informally, as the official announcement of the program was still pending, so none of them could say anything about their new status. Each of them then returned to their duty stations, which for most was at Edwards AFB, and had to carry on as though nothing had happened. That December, Truly and Finley graduated from ARPS, but rather than completing the usual rotation to their naval flight test units, they were held over at ARPS as instructors, pending the official announcement of their selection as MOL astronauts.

For almost a year the situation remained in limbo, during which time one of the candidates (unidentified) dropped out, for reasons which again remain unclear, leaving just 8 pilots. Finally, in August 1965, the MOL program received formal authorization.

Meanwhile, on August 13, 1965, it was announced [2] that NASA had signed an agreement with the USAF on the training of MOL astronauts. Though the details were unclear, it was assumed that this meant the use of training simulators and facilities, as well as conducting one-g simulations and receiving briefings on Gemini systems and procedures. The agreement also called for 128 Air Force officers to be detailed to NASA's Flight Operations Directorate (FOD) at the Manned Spacecraft Center near Houston, Texas. There, they would serve on the same basis as civilian NASA employees for the next two years. The objective of this was to augment the NASA flight operations team and provide the Air Force officers with on-the-job "training and experience in the operational control of manned space flight." In fact, at the time of the announcement, the first contingent of officers had already arrived earlier that month, with others arriving in stages through March 1966. In total, the plan was for the group to consist of 84 lieutenants, 38 captains and 6 majors. Though not announced at the time, these officers would become the leading contenders for Flight Controller positions at MOL's Mission Control in Los Angeles, and as crew trainers for the yet to be selected astronauts.

The following month, NASA initiated its campaign to choose a fifth group of pilot astronauts, while the Air Force was considering a second intake of MOL astronauts. The names of the first eight MOL astronauts were finally made public in November 1965.

[3] Since 1964, Lt. Gen. Bohannon had arranged for a pair of Air Force Flight Surgeons to undertake pilot training annually, to supplement their normal role of gathering biomedical data on pilots from the back seat of high performance aircraft. According to American researcher John Charles, the aim was to create a cadre of pilot-physicians for possible selection as MOL crewmembers. Unfortunately, while several unidentified flight surgeons completed the course, none were selected for MOL training, and details of the program remain classified over 50 years later. [1]

Selection Criteria

Following the authorization to proceed with the Manned Orbiting Laboratory program, by April 1965 the USAF had organized the program management office for the project. Within that office, the Operations and Flight Test Branch was responsible both for developing the operational and test plans and for training the astronauts chosen from USAF personnel.

On February 8, 1965, General Bernard A. Schriever, (Director of the MOL program) wrote a letter to Air Force Chief of Staff, General John P. McConnell, on the topic of recruiting aerospace pilots for assignment to MOL, requesting an early selection of officers to "provide astronaut-type input in the early phases of engineering development on the MOL system." In reply, McConnell noted that it was imperative that Washington retain control of the selection of the best possible officers and especially, considering the sensitive nature of the program, over any public announcement of the names of the selectees. McConnell also reminded Schriever that in the previous selections of officers nominated by the USAF to the NASA program (1959, 1962, and 1963), USAF Headquarters had assembled a selection board to review potential applications for NASA. This same system was expected to be adopted for MOL.

Six months later, in September, a board of general officers was established with the intention of developing and recommending suitable criteria for the selection of the first MOL astronaut group [3]. The chosen criteria resembled those devised for selecting the first groups of NASA pilot astronauts between 1959 and 1963. Therefore, on September 15, 1965, it was announced that any prospective MOL candidates must have:

- The status of a qualified military pilot
- Graduated from the ARPS at Edwards AFB, California
- Be a serving military officer and be recommended by their commanding officer
- Hold U.S. citizenship from birth.

The September 15 announcement also mentioned that the USAF would select a total of 18-20 MOL astronauts in three phases; the first in late 1965, another in 1966 and the third in 1967.

Between September 21 and 28, 1965, the board of general officers held a series of meetings at USAF Headquarters in Washington to ratify that set of criteria. The fact that several officers had already been selected and were awaiting formal identification was overlooked, as was the fact that some of those selected no longer fitted the stated selection criteria.

The First Selection

The October Status Report for MOL (dated November 8, 1965) noted that this initial group of still-unidentified MOL Aerospace Research Pilots (astronauts) had been briefed at Space Systems Division (Los Angeles) on October 16. At this meeting, they learned of the sensitive military aspects of the program they had been selected to join, its importance to national security and the skills they would require when "handling queries associated with the public announcement of their selection." Indeed, the 'sensitive nature' of their selection, and their subsequent assignments along with colleagues chosen in the later groups, remained classified for the next fifty years. So, there was very little public interaction and when there was, nothing much was revealed. The MOL selection board at USAF Headquarters was chaired by General Jerry D. Page, Deputy Chief of Staff for Plans and Programs, and met at Randolph AFB in early November to conduct the preliminary screening of the initial increment of MOL Aerospace Research Pilots under consideration for the first MOL astronaut group.

MOL-I selection group (L to R): Al Crews, Dick Truly, Dick Lawyer, Jim Taylor, Greg Neubeck, Michael Adams, Lachlan MacLeay and Jack Finley (Courtesy Space Facts).

On November 12, 1965, at a press conference held in Los Angeles, the names of the first group of eight of the planned 20 MOL astronaut pilots were announced to the media and public:

Maj. Michael J. ('Mike') Adams, USAF, 35 (b. May 5, 1930, Williston, North Dakota)
Maj. Albert H. ('Al') Crews Jr., USAF, 36 (b. March 23, 1929, El Dorado, Arkansas)
Lt. John L. ('Jack') Finley, US Navy, 29 (b. December 22, 1935, Winchester, Massachusetts)
Capt. Richard E. ('Dick') Lawyer, USAF, 33 (b. November 8, 1932, Los Angeles, California)
Capt. Lachlan ('Mac') MacLeay, USAF, 34 (b. June 13, 1931, St. Louis, Missouri)
Capt. Francis Gregory ('Greg') Neubeck, USAF, 33 (b. April 11, 1932, Washington D.C.)
Maj. James M. ('Jim') Taylor, USAF, 34 (b. November 27, 1930, Stamps, Arkansas), and
Lt. Richard H. ('Dick') Truly, USN, 28 (b. November 12, 1937, Fayette, Mississippi).

Dick Truly had been selected on his 28th birthday, a date which would prove to be very lucky for him. Sixteen years later, on November 12, 1981, now a NASA astronaut, he was launched on his first spaceflight as Pilot of STS-2 on his 44th birthday.

The subsequent MOL Status Report (dated December 9) revealed that the November 12 press conference which introduced the MOL candidates to the media and public was intended as a low-key publicity event, without the high profile of earlier NASA astronaut selections. The report indicated that this intent was accomplished.

The next MOL Status Report announced that the eight MOL Aerospace Research Pilots had been assigned to the MOL Systems Office "to be trained and utilized as flight crew members in the MOL Program," and that "actions were already underway to select the remaining 12 pilots required to fulfill the 20 places planned for the MOL astronaut program" [4].

Truly explains the background to the first MOL selection

In June 2005, Richard Truly sat down with NASA JSC Oral History program interviewer Rebecca Wright and went through his selection to both the MOL program and NASA, and it is worthwhile sharing his reflections on that dynamic period in his life, and how the selection process for both programs evolved.

"The Air Force had a [space] program called Dyna Soar, and as a matter of fact, during that [westward] trip, after I had left Oceana and was driving to Edwards, the Air Force announced that the Dyna Soar Program was being cancelled. But at the same time, they announced they were going to start a new space program, which was going to be an orbital space station, if you will, called the Manned Orbiting Laboratory, or MOL. That didn't [interest] me, since I [felt] that I was not qualified to be an astronaut. I had never thought about it. The Mercury guys had been selected to NASA, but, I never even dreamed that I would be able to ever do something like that.

"So, we started into that test pilot training during [1964], and all of us in the school knew that MOL was coming and Dyna Soar had been cancelled. But I was working hard [just] to get through the test pilot school, and I wasn't thinking about flying in space. Well, it turned out that unbeknown to all the students in the school, Chuck Yeager and [an officer] who worked for him named 'Buck' Buchanan, who was an Air Force lieutenant colonel at the time… had gone to Air Force [Headquarters in Washington, D.C.] and had convinced the Air Force that the first group of MOL astronauts to be selected had to be graduates of the Aerospace Research Pilot School that I was attending.

"The first six months of [the curriculum] was test pilot school and the last six months of it was more about space, where you learned about orbital mechanics and spacecraft systems and digital computers and all of that. You've got to remember this was 1964, so a lot of this really [was] cutting-edge stuff. Well, as we got about two-thirds or three-quarters of the way through 1964, through my test pilot training, suddenly we realized that [the Air Force] had limited the number of [MOL] candidates just to graduates of this school, and they had [further] decided to include our class, even though we wouldn't graduate until December of that year. The other thing that they didn't tell anybody was that, without ever asking for applications, Yeager had convinced the Air Force that the graduates of the school, of which there were only 85 including our class, [would all] want to do it, and so they started a selection without anybody knowing it. The candidates to be eventually selected, in other words, the candidates to be selected in that first MOL class, were [from] the 85 graduates of the school.

"Now, finally, I realized that our names were in this selection, but it still didn't [register that I had a chance]. I mean, some of the world's most famous test pilots had already graduated from the school. They were setting world records right and left in the X-15 and other airplanes at the time. So, again, it didn't occur to me that I had any chance of being selected. But suddenly, I did realize that my name was in that pot.

"Meanwhile, down at NASA, [they were] selecting more and more crews, and a lot of people that were in the test pilot school made the choice: either 'I only want to go to NASA,' or, 'I'll do anything.' A lot of them [later flew] to the Moon. [Many] were [from] that same group of people that were graduates of this school.

"Come November or so of 1964, Yeager and Buchanan flew to Washington, and they were completing their [secret] selection and had gone through everybody's records. There was a selection board. They came back and, I'll be damned, I got selected, and so did [Jack] Finley. So, there were originally [nine] people that were identified for the MOL Program, but they weren't going to announce the selection until the Air Force formally announced the beginning of the program, because they needed money from Congress. There were [seven] Air Force and two Navy. I was the youngest.

"[In December] I graduated from test pilot school, and the Air Force had to hang on to Finley and me. They didn't want to send us back to the Navy, because they had us there. So, they decided to keep us at Edwards, and the Navy agreed to this, while the Air Force was waiting to announce the MOL program. They kept us at Edwards as instructors in the Aerospace Research Pilot School. So, in 1965, I became a test pilot instructor.

"During that next year, one of the [nine] crewmen had some sort of a medical problem or something [and dropped off the list], and so on November 12th of 1965, there was [an Air Force] press conference [in Los Angeles]. I remember that date well, because it was my 28th birthday… They formally announced the first MOL crew, or group of astronaut selections, and it was [eight] people. It was the remaining [six] Air Force, less the one that had been taken out of consideration, [plus] Jack Finley and me… In the summer of 1966, Michael J. Adams left the MOL program to return to Edwards and fly the X-15. That left seven of us, and we jokingly referred to ourselves as 'the magnificent seven', after the movie. So suddenly, I was in an astronaut program, and we worked like the devil from that day until that program was eventually cancelled in 1969 by President Nixon."

The unidentified 'ninth candidate'

For many years, observers of the program appeared not to question that some of those selected in November 1965 did not actually meet the requirements criteria issued just two months earlier. Adams, Taylor and Lawyer were at the upper age limit and it is somewhat ironic that Al Crews, at 36, was 'officially' too old for MOL and yet had previously been the youngest member of the group chosen to fly the now cancelled X-20 Dyna Soar. As the oldest of the candidates, he became the unofficial leader of the group for the next few years [5]. The reality was that the group had been evaluated and chosen over a year earlier under a different set of guidelines, but their names had not been announced. By the time they were, few questioned the discrepancies.

For some time, there were rumors that a ninth candidate had been chosen but not announced. American author and respected 'space sleuth', Michael Cassutt, has conducted extensive research into the selections of both USAF and NASA astronauts and attempted to discover who the missing ninth man of MOL-I could be. Confirmation that a ninth man did indeed exist came in 2005, when NASA published the first part of Richard Truly's Oral History, in which he confirmed that nine pilots were selected in the first Group of MOL candidates, though only eight were publicly announced.

In subsequent research, Cassutt began to re-examine the backgrounds of Rupp, Henry, Knight and Tonini one by one. He found out that Al Rupp had died in a plane crash on June 11, 1965, five months prior to the MOL announcement. Forty years later, during an interview in November 2005, Al Atwell confirmed that he was indeed under consideration as a MOL candidate for that first selection, but had been medically disqualified. Then, in February 2006, Tommy Bell confirmed that while he was indeed part of the MOL selection process, he was *not* in the final selection. Bell identified what he called 'the significant six', but unfortunately did not clarify whether this referred to those who did not make the selection or those who did, which did little to clear up the matter. That same month, Tonini confirmed he had undertaken medical tests for MOL and though he came in fifth out of six, he was disqualified, like Rupp, for a minor medical condition. Of the remaining candidates, Cassutt thought Pete Knight clearly stood out as a leading possibility for the 'ninth man'. Knight had previously been selected for the cancelled X-20, and had completed the space plane course at ARPS, before joining the X-15 program in 1965 after failing to progress to MOL. Another candidate was Robert Beale, a class member of ARPS 63A along with Knight, Lawyer and Taylor, although when interviewed in 2006, Beale denied any involvement in MOL. This was not that surprising when one considers that, at the time of his interview, the program would still be classified for almost another decade [6].

Mac Macleay revealed in a subsequent interview that he was almost immediately assigned to participate in a series of Apollo simulations at the Martin Facility in Baltimore, following graduation from ARPS in December 1963, together with Al Atwell and one James B. Irwin (who in April 1966 was selected as one of 19 NASA Group 5 astronauts). These were follow-on simulations to those completed between January and June 1963 by Al Crews and William Campbell. After the tests were completed, Macleay was assigned to the F-4C test team. At the time, and for many years afterwards, no one thought that the criteria for selection, nor those actually selected, were out of the ordinary. It was not until the official release of declassified files, 50 years after the fact, that the truth was finally revealed.

Mike Cassutt takes up Macleay's story: "Sometime in late spring or early summer 1964, Buck Buchanan took Macleay aside and told him about the upcoming Manned Orbiting Laboratory program, [and] that only ARPS graduates were going to be eligible for selection. Macleay expressed interest, and in October 1964 found himself at Brooks with 14 other candidates" [7]. Macleay confirmed that several of the group failed to pass the physical at Brooks, and admitted that he, too, "had a tough time winning approval." The remaining candidates then went on to a day-long selection board process held at Andrews AFB. Macleay recalled that he had to wait almost the entire day before he met the board. That night, at the Officers' Club on site at Andrews, he was told he had "made the cut." Though originally the Air Force had planned to select only six, it had been decided that Finley and Truly had also made it, as representatives of the Navy. With the news of their success, the seven new MOL pilot astronauts stationed at Edwards (Greg Neubeck was still at Tyndall AFB, Florida) held a big party that night at Macleay's quarters. Unfortunately, that high point of selection soon diminished as the program dragged on over the next four years, with little sign of the manned launch they had all hoped for.

Changing the rules

"After that first MOL selection," Dick Truly recalled in his NASA Oral history, "a lot of other [pilots] in the Air Force really complained because they didn't get a chance to be selected. Some of them had gone to graduate school and gotten doctorates and this and that. So the Air Force changed the rules after that first selection, and then they had a formal selection where you had to apply. Then all the applications would come in, and you would be considered [and then] they'd do a selection, and so there were a couple [more] MOL groups of [pilots] that [joined] the MOL flight crew during that period."

NASA CALLS FOR NEW ASTRONAUTS

On September 10, 1965, a few days before the USAF announced the selection criteria for the MOL astronauts they had already chosen the year before, NASA issued the call for a new, fifth group of pilot astronauts [8]. By the fall of 1965, NASA already had 28 active pilot and two scientist astronauts, with another three scientists undergoing flight training. The space agency, looking to the future, realized this was sufficient for Gemini and the early Apollo missions, but not for what it had planned for the 1970s. As a result, a new selection effort was organized, split into two phases, which was intended to recruit enough astronauts to provide crews for the next two decades.

In this first phase, NASA announced, a new group of pilot astronauts was necessary "to insure availability of an adequate number of flight crews for Project Apollo and future manned missions." In the same release, it was stated that an additional group of scientist astronauts would be selected in the second phase "within the next year."

The first phase was expected to be completed by the spring of 1966, with the new astronauts reporting for duty at NASA MSC, Houston, Texas, that summer. The selection criteria were similar, but not identical, to those of the 1963 pilot astronaut selection:

- Be a citizen of the United States
- Be no taller than 6 feet
- Born on or after December 1, 1929
- Hold a bachelor degree in electrical, physical, or biological sciences
- Have acquired either 1,000 hours jet pilot time, or be a graduate of an armed forces test pilot school

These astronauts would not be flying Gemini missions, but the height restriction was imposed to ensure that the candidates could fit comfortably inside the far roomier Apollo Command and Lunar Modules, and negotiate the various hatches, while wearing pressurized spacesuits. The dimensions and capacity of the Saturn launch vehicles, designed to carry the spacecraft into space, governed the sizing parameters of the spacecraft in which the astronauts would ride.

For this selection, the age limit was raised from 34 to 36, which potentially offered a 20-year career at NASA. As it turned out, several of the successful candidates would use up almost all of this career projection before they had their first opportunity to fly in space. One aspect not made clear in the release was the fact that the call was also open to both females and minority candidates. At this point in the mid-1960s, however, there were still too few of either category who were qualified to meet even the minimum requirements. It was also expected that few suitable pilots under the age of 28 would have accrued sufficient education, qualifications and experience to be able to apply with confidence [9].

In his 2001 NASA Oral History, U.S. Marine Jack Lousma explained that when he put in his application with the Marine Corps, who were supportive of his application, the selection board rejected it due to him being recorded as 6 ft. 1 in. tall during his last physical. Lousma could not believe it and re-measured himself just to make sure. Standing against a door frame, and taking height measurements every morning and evening over several days, he found that by nightfall he was about an inch shorter than in the morning (during the night in the prone position in bed, his spine had relaxed, but while standing up in the day he shrunk slightly over the course of several hours, due to gravity compressing his spine). Thus, Lousma practiced standing all day, and by 'hunkering down', found that he came in under six feet. He went back to the medics, hoping they would re-measure him late in the day. The same Marine flight surgeon awarded Lousma a 'special re-measure' and this time his height was recorded at 5 ft. 11 and seven-eighths inches. Given this reprieve, he decided not to tell anybody he was really "five feet thirteen inches tall," and said he had to do a lot of "scrunching down" when NASA medics measured him later at Brooks AFB.

All applicants were expected to be able to pass a Class-1 flight physical examination, which included the requirement for 20/20 uncorrected vision. It was also requested that civilian and military reservists were to submit a standard Civil Service Form 57 Application for Federal Employment, which was available at any U.S. Post Office. A résumé of their employment experiences and academic training was also required and all civilian applicants were further required to submit a statement of their total jet flying time.

Military candidates were required to apply through their respective services, while others could send their application directly, with a postmark of no later than December 1, 1965, to the Astronaut Office[4] at MSC. In October 1965, the '*All Marines*' bulletin, circulated to every Marine Corp Unit, reported the NASA call for applicants. The Air Force and Navy had comparable bulletins to inform their own service personnel. Maj. Jerry Carr, a pilot with MAC-3, was one of the Marines who read that announcement and, after discussing the option with his wife, decided there was probably no more danger involved in being an astronaut than in flying combat missions in Vietnam. For both, it was a case of learning to live with the odds. What helped to persuade him was that his old Marine fighter pilot friend, C.C. Williams, had been selected by NASA in the third group of astronauts in

---

[4] Over time the MSC/JSC 'CB' mail code for the Astronaut Office became a verbal shorthand for several astronauts, though just as many still called it "the Office," which the authors have adhered to where possible in this book.

October 1963. Carr thought, “Well, C.C. made it, maybe I can.” Knowing he possessed the right credentials, Carr wanted to see “how I measured up,” formally commencing his application on October 27, 1965. He was genuinely surprised when he found out he had made the first cut by progressing through the USMC astronaut selection panel [10].

Each military applicant had to secure letters of recommendation from former and current commanding officers, together with their last flight physical examination, a multi-section Statement of Personal History (DD398 Standard Form 86), the Application for Federal Employment (Standard Form 57) and a summary of his aviation training. Carr completed the forms, which had to arrive at the USMC Astronaut Selection Board at Marine Corps Headquarters by November 25 for onward transmission to NASA. Then began the long wait. In a letter dated December 17 from the USMC Deputy Chief of Staff (Air), Carr was informed that he had been successful in his application as a Marine Corps nominee and was recommended to NASA for astronaut training. In 2001, Jack Lousma said that a total of six marines made the cut for examination at Brooks, including himself and Carr.

They did not know it at the time, but both Carr and Lousma’s qualifications and performance of duties were so highly rated that the USMC selection board had also forwarded their names to the Chief of Staff of the USAF for possible consideration in the Air Force’s MOL program.

The Marine selection board recommended several names for further consideration for astronaut training, along with Carr and Lousma, including a second pilot from MAC-3, Capt. Stanley P. Lewis, and a Capt. Robert F. Overmyer. Finally, just five days before Christmas 1965, Carr received word from NASA that he had progressed to the next stage and was required to spend a week at Brooks AFB, San Antonio, in either January or February 1966. If he passed that series of evaluations, he would have to attend the final evaluations, held over a week in Houston, home of the Manned Spacecraft Center.

Each successful applicant had been given a great Christmas present, but one which they could not ‘open’ to enjoy, as most of the remaining candidates under consideration would not be selected and their identities would, as far as possible, remain undisclosed. The still-sensitive nature of the process was made clear to each remaining candidate. They were told to have as little discussion as possible on the subject with family members, which proved to be another challenging task.

Late in 1965, civilian test pilot Vance Brand was living and working in France for the Lockheed-California Company, where he was assigned to cooperate with representatives from West Germany. Stationed at a southern French air base, they were developing the flight test capabilities of the F-104G intended to be used by the Europeans. Upon reading a copy of *Aviation Week*, he spotted a small and rather inconspicuous notice stating that NASA was seeking a new class of astronauts. Brand had applied for NASA in 1963 and had reached the final 34, so he thought he should apply again. It meant a couple of long flights back to the United States for interviews and medicals, but it eventually proved worth the effort [11].

Air Force pilot Jim Irwin had also tried to enter the astronaut program before. After graduating from ARPS, he had also applied for Group 3 in 1963 and, like Brand, had reached the final 34 but progressed no further. None of the unsuccessful applicants were told why they were *not* selected, but Irwin believed a recent air accident had probably influenced NASA's decision to reject him. He had tried again in 1964, but this time NASA had been on the lookout for scientists, not pilots, so he was turned down again: "This was a serious blow because I was fast approaching the age limit and it looked to me as though any chance I had was fast diminishing" [12]. But in the fall of 1965, he tried for the third and, he thought, probably his final time.

Ed Mitchell had pursued a much longer path to selection. Excited about the space program since the Soviets had launched Sputnik in October 1957, Mitchell was too young to apply for the first NASA group in 1959 and did not have enough jet time for the 1962 or 1963 selections, so he decided to advance his academic career and flying experiences to increase his chances of selection in a later group. Following graduation from MIT in 1964 he applied, and was accepted, to the Guidance Control Directorate at NASA's Manned Spacecraft Center in Houston. Deciding to drive from MIT in Cambridge, Massachusetts, to their new home in Houston, Mitchell and his young family took a break in the long drive and stopped over at his mother-in-law's home in Pennsylvania. While there, he received a telegram from a Capt. Jack van Ness, informing him that the Navy had assigned him to work for van Ness on the MOL program in Los Angeles. Disappointed not to be heading for Texas but following orders, Mitchell and his family diverted their journey to California, a trip which took five days. For the next 18 months, Mitchell worked on the MOL program as van Ness's deputy, "managing and coordinating the design for the orbital craft and its sensors. But once it became clear to me that the orbiting lab project was starting to stall, I realized this job wasn't going to help me get to the Moon." As exhilarating as the challenge of MOL might be, he soon realized that management skills alone would not be enough to provide a ticket for space. Working inside the program, he learned that most of the pilots being selected as MOL astronauts were either experienced test pilots or young fighter pilots. In 1965, Mitchell was neither a test pilot nor getting any younger. Therefore, he decided to pursue an appointment in the ARPS program at Edwards, which he hoped would help in his quest to be selected by NASA in 1966 [13].

Halfway around the world, U.S. Navy pilot Paul Weitz was completing a combat tour in Vietnam and had not given much thought to the NASA program. But while he was deployed to the Western Pacific, Weitz received an interesting message from the Bureau of Navy Personnel. In it, he was told that NASA was seeking applications for a new group of astronauts, and as he met the Navy's criteria and the space agency's qualifications, he was being given the chance to apply. He responded in the affirmative, and on his return to the United States went through the selection process [14].

With the USAF also searching for more MOL astronauts at the same time, for each of the military applicants there was the opportunity to apply for the NASA astronaut program, the classified MOL program, or both. This was not apparently the case for USN applicants, however, where candidates had to choose to apply for one or the other. Air Force pilot Al Worden decided to apply to NASA: "I figured the Air Force would steal all of the best pilots from the dual selection but would never get their own space program off the ground. I didn't know much about NASA yet, but I knew the Air Force didn't have a good track record for that kind of program" [15].

Another Air Force pilot, Charlie Duke, was reading a copy of the *Los Angeles Times* one Sunday morning and saw on the front page an article announcing that NASA was seeking more astronauts. He found out that the USAF was also seeking a new group of astronauts, realized he met all the stated qualifications and decided to apply; but to which – NASA or the USAF? Stationed at the time at Edwards AFB, Duke had his options made very clear by Buck Buchanan, now the Deputy Commandant of the Test Pilot School at Edwards, who told him, "You can apply for NASA, you can apply for MOL, and you can apply for both. But if you apply for both, I guarantee you we are going to pick you for MOL and not let NASA have y'all" [**16**].

X-15 pilot Joe Engle knew his time at Edwards, flying the hottest plane in country, was limited. He fully expected to be reassigned within a year due to the natural Air Force policy of rotating its officers to other assignments to afford them a diverse career. He would leave Edwards with mixed emotions, but realized that his skills might be called upon one day to guide one of the controllable re-entry vehicles back through the atmosphere from space. These types of vehicle were being studied for future operations and though Engle would be happy to be selected to fly to the Moon, he was also looking to future developments in re-entry vehicle technology, then being evaluated with lifting bodies. Of course, these developments would eventually lead to the Space Shuttle he would find himself piloting in the atmospheric test flights of 1977 and the two space missions he would command in 1981 and 1985 [**17**].

Naval aviator Ron Evans was the Electronics Officer for VF-51, on combat deployment in south east Asia, when notified of his selection by NASA. But there was a problem, as his wife Janet explained in 2012. "Ron was on his second tour to Vietnam on the *USS Ticonderoga* and a large envelope arrived addressed to Ron and of course I opened it. In it was a stack of forms and a cover letter, and it said, 'You have the basic qualifications for astronaut training. Do you wish to volunteer? If so, fill out the forms [and] return them to NASA within ten days. Signed, Deke Slayton.' It took about thirty minutes for me to find out how to get hold of Deke on the telephone and I explained to him, 'Yes, Ron Evans volunteers for astronaut training, but I can't get the forms to him, and he back to you, within ten days.' Deke chuckled and said he will accept them late. And that was the beginning of a wonderful family venture" [**18**].

In early January, NASA reported that detailed evaluations of the applicants for the new astronaut group were well underway [**19**]. Prior to the deadline of December 1, 1965, a total of 5,000 hopefuls had applied for consideration, but only 351 met the basic requirements. Unfortunately, this did not include any of the six women who applied for the selection, because none of them possessed the minimum qualifications. Though not specified, this probably meant they had not accrued the minimum jet pilot time, or were not graduates of a military test pilot school. This was not surprising, as during the 1960s women were still not eligible to apply for military jet pilot courses in the United States.

Of those who did meet the qualifications, 159 names were put forward for further consideration, including 100 members of the military services and 59 civilians. The news release indicated that up to 15 (not the 20 that had been quoted earlier) qualified applicants would be selected, with the names of those who were successful revealed by May [**20**].

Ironically, one future Group 5 astronaut, USAF Maj. Edward Givens, then attached to the USAF Astronaut Maneuvering Unit Project Office, had already been featured in the MSC *Space News Roundup* magazine on December 10, 1965. In an image on page 3, he is seen with the original Gemini 9 pilot Charles Bassett and his backup Gene Cernan at the Ling-Temco-Vought plant in Dallas, reviewing the AMU unit prior to its acceptance by the Air Force Space Division.

However, one applicant who did not make the final selection process was a young USN aviator, Lt. Frank K. Ellis, who in July 1962 had lost both legs following a jet crash. In his application, Ellis maintained that despite his handicap, his flying skills remained unimpaired, and in the role of astronaut in zero-g, being unable to run or jump was irrelevant for him to complete his tasks. His application and tenacity in the face of adversity so impressed NASA that the agency offered Ellis the opportunity to complete some special work for them.

MAKING THE CUT

Following the initial application and evaluation, a total of 44 men were chosen to undergo a 'working week' of medical tests at Brooks AFB, over a period of ten days. Such was the size of the group, together with the pressure for nominal service medicals, that they were to report over a period of six weeks between January 7 and February 15, 1966.

The 44 (with the date they arrived at Brooks) were:

January 7	Lt. Milton H. Bank, USN
	Lt. Richard L. Martin, USN
	Lt. Dwight D. Timm, USN
January 12	Lt. John S. Bull, USN
January 14	Lt. Harry L. Blackburn, USN
	Lt. Cmdr. Paul J. Weitz, USN
	Lt. Robert V. Sallada, USN
January 17	Capt. Gerald P. Carr, USMC[5]
	Lt. Bruce McCandless II, USN
	Cdr. Jack O'Hara, USN
January 21	Lt. Thomas K. Mattingly II, USN
	Lt. Cmdr. Edgar D. Mitchell, USN
	Mr. John L. Swigert, Jr
January 24 *or*	Maj. John A. Graff, USAF
January 28	Maj. James B. Irwin, USAF
[Conflicting data]	Capt. Ernest A. Olds, USAF
January 25	Capt. John D. Carlton, USMC
	Capt. Jack R. Lousma, USMC
	Capt. John Metzko, USMC
January 26	Capt. Charles M. Duke, Jr. USAF
	Capt. Joe H. Engle, USAF
	Maj. William R. Pogue, USAF
January 27	Maj. Ernest L. Hatchell, USAF
	Capt. Stuart A. Roosa, USAF
	Capt. Alfred M. Worden, USAF[6]

---

[5] The original correspondence to Jerry Carr, filed in his personal correspondence, was dated January 6. This letter stated he was to forward medical and dental records to Brooks by January 10 and to report there by January 19 for medical evaluations starting the next day.

[6] In his 2011 biography, Al Worden says he shared a room at Brooks with MOL candidate Robert Lawrence, whom he found to be "one of the nicest, down to earth guys I ever met." [Worden 2011 p. 56], However on the MOL candidate listing for medicals, Lawrence is listed as being at Brooks from February 3, 1966, not January 27.

February 7	Capt. George F. Heinrich, USAF
	Capt. Richard E. Cherry, Jr., USAF
	Mr. Richard A. Laidley
February 8	Mr. Darryl Greenamyer
	Mr. Fred W. Haise, Jr.,
February 9	Mr. Hugh M. Jackson
	Mr. Norman P. Shyken
	Dr. Milton Matter, Jr. M.D.
February 10	Lt. Cmdr. Peter A. Banks, USN
	Lt. John W. Holtzclaw, USN
	Lt. Dwight C. Owings, USN
February 11	Mr. Charles J. Howard
	Lt. Ronald E. Evans, USN
	Lt. Cmdr. George Furlong, Jr., USN
February 14	Mr. Don L. Lind
	Mr. Thomas R. Kloves
	Mr. M. Peter Frank
February 15	Mr. Vance D. Brand
	Maj. Edward G. Givens Jr., USAF

Of these individuals, Jack Swigert had previously applied for NASA Group 2 in 1962 and had reached the final 32, completing his medicals on July 25 that year. Vance Brand, Lt. Ron Evans, USN, Lt. George Furlong USN, and Capt. Jim Irwin USAF, had all applied for NASA Group 3 in 1963, together with Swigert who was trying for the second time. These men had received their medicals on August 2, (Irwin), August 5, (Furlong), August 8 (Brand and Evans) and August 14 (Swigert) 1963 [21].

Former USN jet pilot and research scientist Don Lind had also applied in 1963, thinking his PhD would count in lieu of the required 1000 piloting hours (he only had 850), but was not even shortlisted. He understood that the formal qualifications had to be met, acknowledging, "you couldn't just send in an application like a cereal-box top and get your space badge," but argued with himself that a PhD was surely worth 150 hours of jet pilot time. Lind appealed and requested a waiver of the requirement he had not met, but was refused. Instead of taking the word 'No' for an answer, he flew down to Houston, but without success, learning that 'No' from NASA really did mean 'No'. Undeterred, Lind took the view that "No, not this time, did not mean no, not ever." However, despite his frustration, wisdom prevailed in not asking if 150 hours spent in an elm tree as a child pretending to be a pilot would be acceptable instead! He almost quit trying, but applied again in 1964 for the first scientist astronaut selection, where academic qualifications counted more than flying skills. By now, he had made up his 150 hours flying for the Naval Reserve and had gained a PhD in high-energy nuclear physics. Much to his frustration, however, Lind learned that NASA had recently included an age limit on the criteria list and he was now 79 days too old! "Even with the help of the elm tree, the Naval Reserve, and the PhD, there was no possible way I would be able to overcome that requirement." Once again, he would not give up. He tried to reason that since the non-pilots of the group were required to spend a year at flight school, as an already-qualified Navy jet pilot, he could save NASA money by not undergoing flight training. In addition, once the non-pilots had graduated from flight school, the 79-day difference would not mean much. This did not work out for him either, and he failed for the second time to be shortlisted. By 1965 and his third attempt at joining the astronaut program, Lind finally met all the criteria perfectly. Now working at NASA Goddard, he said that when he contacted NASA with his renewed application, the comment was, "Oh, yes. Dr. Lind, we were wondering when you would call." He surmised that his rather thick personal folder was taken out of the drawer and dusted off to sit on the application pile once again. He figured that NASA officials probably approved his physical at Brooks just to get him off their backs [22].

Pleasant, enlightening, and exciting times at Brooks AFB

The medical program at Brooks was introduced to the candidates by Capt. Lawrence J. Enders, Chief of the Flight Medical Evaluation Section. He explained the program as "pleasant and enlightening, and even exciting at times; certainly, the most thorough medical examination you will ever have." After they had endured the barrage of tests, examinations and activities, each applicant could testify to at least the second half of that statement.

In his 2001 oral history, Jack Lousma recalled that there were six days of tests; four medical and two psychological, while Don Lind thought the medical test program had probably originated from the Inquisition, [23] with the first batch related to the heart, including vector cardiograms and electro-cardiograms. For stamina tests, they pounded a treadmill from "just too fast for a walk to 20 minutes testing on a 20 percent slope." Then there were the tests which probed the candidates' personalities, motivation, stability and dignity, and questions on their families, their hobbies, their faiths and likes or dislikes. Each candidate and their immediate families had been subjected to an extensive FBI check and references going back to their childhood. Never before, or probably since, had each applicant been so deeply investigated, pushed, prodded, examined and questioned.

Immortalized in Tom Wolfe's 1979 book, *The Right Stuff* and in the 1984 film of the same name, the week's program at Brooks AFB subjected each candidate to a battery of invasive and exhausting physical and psychological tests and evaluations. The psychologists had the candidates conduct the Rorschach ink-blot tests, with the candidates careful in what they interpreted seeing in the inkblots. The secret was apparently not to give responses that were too complicated, and certainly nothing weird or overtly sexual. The week also involved encephalogram or brain wave tests, sessions on a centrifuge, balance tests and tests to determine the endurance and strength of their cardiovascular and vestibular systems. Duke recalled a whole day of electro-cardiogram tests and being strapped to a table which would roll and rotate into inverted positions [24].

Then there were the tests which very few candidates understood, more akin to medieval torture chamber devices than 20th Century medical tests, such as plunging their right hand in hot water and having cold water poured into their ears. In his 1990 biography, Charles Duke recalled his experiences: "The whole process featured being poked, prodded, tested and analyzed from every angle, in every conceivable position, and from every opening of our bodies" [25]. The tests were so extensive that there were some Duke could not pronounce, never mind work out what they were for.

Jerry Carr discovered that he had mildly flat feet and had suffered hay fever during his week at Brooks. Realizing he was not as perfect a specimen as he thought, he assumed he would not get any further, but when a letter arrived a few days later, he was relieved to read he had reached the second cut and was invited to attend the interviews in Houston.

Early in the USAF selection phase, ex-Thunderbird pilot Bill Pogue underwent his medical at Edwards. When one of his blood pressure readings was too high, it meant that, officially, he could not be cleared to progress through the selection process. A more serious consequence was the possibility of being grounded from flying. Pogue finally convinced the medics not to report the situation immediately, allowing the NASA selection process at Brooks to determine the true status of his blood pressure. This was a fortunate move, as the NASA evaluations utilized an automated device that recorded the candidate's readings every fifteen minutes for three hours. Pogue again had one recording slightly high, but another was almost too low. Overall, he had satisfied the Brooks staff and passed the medical, keeping his flying status and moving to the next phase of the selection process [26].

"As many qualified guys as you find"

In his 1994 biography, written with Michael Cassutt, Deke Slayton admitted having mixed feelings about selecting another group of pilots: "I knew I had enough guys in the first three groups to get through the first Moon landing, and then some" [27]. But as early as 1964, serious plans were being developed for what was hoped to follow Apollo as America's next step in space, including cautious expectations of multiple landings on the Moon. In addition to a series of lunar expeditions, plans were being developed to conduct a range of missions in Earth orbit, under what was called the Apollo Applications Program (AAP). On paper, this amounted to up to 30 missions. Even discounting further lunar landing or orbital flights under the Apollo label, there would be an additional projected eighteen AAP flights, offering 48 flight seats. "Even if everybody flew twice," Slayton wrote, "that was still twenty-four astronauts. So, when the selection panel asked how many guys I wanted to hire out of the 35 finalists, I said, 'As many qualified guys as you find'."

Weitz observed that they were the first group to go to the interviews without having first been given assumed names to hide their identities from the media. He thought at the time that he had not done well in the interview, while his roommate felt he'd "really aced his interview." In fact, Weitz made it and his roommate didn't [14]. Years later, Weitz would serve on three astronaut selection boards himself, together with George Abbey, a future director of the Johnson Space Center (JSC).

On February 27, Jerry Carr flew to Houston to be met by a representative from NASA and taken to the Rice Hotel, where he and the other remaining candidates would stay while completing the next stage. Their interviews were scheduled for two days' time (March 1), but the next day, February 28, came the tragic news that astronauts Elliot M. See and Charles A. Bassett II had been killed in the crash of their T-38 jet, as it tried to land near the McDonnell plant in St. Louis, Missouri that housed their intended Gemini 9 spacecraft. Carr recalls seeing people nervous and distracted as the tragic news cast a shadow over proceedings at the hotel. Clearly this was a sobering reminder of the dangers of jet flying, even outside a war-zone and combat operations. Many of the successful applicants have remarked how this event was one clear memory from that time. Military pilots can become accustomed to hearing of losses, especially of close friends and colleagues, but nevertheless it is still painful and a clear reminder of the risky business they are in.

The next day, the selection panel continued their program in one of the ballrooms at the hotel. More than 50 years after enduring the process, Carr could still vividly recall entering the large room, with a long table covered in a green table cloth, seven stern-looking men sitting behind it… and a lonely empty chair facing them. That chair was positioned under a spotlight, which made Jerry think that the situation looked more like a court martial than an interview.

The seven members of the Group 5 Selection Board were: Assistant Director of Flight Crew Operations, Deke Slayton; Chief Astronaut, Alan Shepard; Gemini 10 commander, John Young (representing the Navy); Gemini 10 pilot, Michael Collins (Air Force); and Gemini 10 back-up pilot, C.C. Williams (USMC); together with spacecraft designer Max Faget and astronaut training officer Warren North.

The interview began by trying to make the applicant feel relaxed, not intimidated, with a friendly exchange of information from both sides, although for the applicants this was still a daunting discussion. The Pilot Selection Panel then "fired the broadside," shooting questions from different angles on a variety of subjects. Each man was quizzed as to why they wanted to become an astronaut, about their careers and achievements, and their knowledge of the program, while all the time under the scrutiny of the panel, evaluating the responses and their composure. The week in Houston also featured tours of the Manned Spacecraft Center, as well as further written tests and briefings. Once the interviews were over, the candidates were told to expect the results by early April and each then returned to their current posts. In early March, the Selection Board assembled at Rice University, Houston, to review the data collected on each of the final applicants, prior to selecting the final group who were to be publicly named the next month.

In mid-March, as the candidates awaited news of their application, NASA flew the Gemini 8 mission. Crewed by Neil Armstrong and Dave Scott, Gemini 8 successfully completed the first docking in space, using an unmanned Agena target. A short time later, however, a thruster on the Gemini became stuck open, causing the spacecraft to spin wildly, forcing an emergency undocking and early retro-fire, and resulting in a splash-down in the Atlantic Ocean just ten hours into a planned three-day mission. In his oral history, Carr recalled the event, and how it captured his attention, having just applied to the NASA astronaut program. The Gemini 8 incident was a sobering one, about which Carr thought; "maybe it made a few of our guys say, 'Gee, I wonder what we've gotten ourselves into here'."

NASA's Group 5 astronauts with support staff. (Back row, in suits, standing L to R): Jack Swigert, Jerry Carr, Paul Weitz, Al Worden, Ed Mitchell, Jim Irwin, John Bull, Fred Haise, Vance Brand, Ken Mattingly. (Front row, seated L to R) Ron Evans, Stu Roosa, Charlie Duke, Ed Givens, Joe Engle, Don Lind, Jack Lousma, Bill Pogue and Bruce McCandless.

And 19 make 50

On April 4, 1966, just over two weeks after the dramatic events of Gemini 8, NASA announced the names of the 19 new astronauts that formed its fifth group of astronauts and fourth pilot selection [28]. Deke Slayton's earlier recommendation that they select as many qualified guys as they could had obviously been heeded. Within the group were four civilians, as well as seven chosen from the Air Force, six from the Navy and two seconded from the Marine Corps. NASA also released some selection statistics, which revealed that the average age of the group was 32.8 years, the average number of college years attained was 5.8 and the average flight time logged was 2,714 hours, with 1,925 of that in jets. Two of the new astronauts held doctorates (Lind and Mitchell) and all but two (Mattingly and Swigert) were married. The nineteen were:

Mr. Vance D. Brand, 34, (b. May 9, 1931, Longmont, Colorado)
Lt. John S. Bull, 31, USN (b. September 25, 1934, Memphis, Tennessee)
Maj. Gerald P. ('Jerry') Carr, 33, USMC (b. August 22, 1932, Denver, Colorado)
Capt. Charles M. ('Charlie') Duke, Jr., 30, USAF (b. October 3, 1935, Charlotte, North Carolina)
Capt. Joe H. Engle, 33, USAF (b. August 26, 1932, Abilene, Kansas)
Lt. Cmdr. Ronald E. ('Ron') Evans, 32, USN (b. November 10, 1933, St. Francis, Kansas)
Maj. Edward G. ('Ed') Givens, Jr., USAF (b. January 5, 1930, Quanah, Texas)

Mr. Fred W. Haise, Jr., 32, (b. November 14, 1933, Biloxi, Mississippi)
Maj. James B. ('Jim') Irwin, 36, USAF (b. March 7, 1930, Pittsburgh, Pennsylvania)
Dr. Don L. Lind, PhD, 35 (b. May 18, 1930, Murray, Utah)
Capt. Jack R. Lousma, 30, USMC (b. February 29, 1936, Grand Rapids, Michigan)
Lt. Thomas K. ('TK' or 'Ken') Mattingly II, 30, USN (b. March 17, 1936, Chicago, Illinois)
Lt. Bruce McCandless II, 28, USN (b. June 8, 1937, Boston, Massachusetts)
Lt. Cmdr. Edgar D. ('Ed') Mitchell, PhD, 35, USN (b. September 17, 1930, Hereford, Texas)
Maj. William R. ('Bill') Pogue, 36, USAF, (b. January 23, 1930, Okemah, Oklahoma)
Capt. Stuart A. ('Stu') Roosa, 32, USAF, (b. August 16, 1933, Durango, Colorado)
Mr. John L. ('Jack') Swigert, 34, (b. August 30, 1931, Denver, Colorado)
Lt. Cmdr. Paul J. ('PJ') Weitz, 33, USN, (b. July 25, 1932, Erie, Pennsylvania)
Capt. Alfred M. ('Al') Worden, 34, USAF, (b. February 7, 1932, Jackson, Michigan)

Though told they had 30 days to report, the new group was officially to report to the Manned Spacecraft Center, Houston, Texas, for NASA assignment by May 1. With three of the ARPS Class 64C members, Charlie Duke, Stu Roosa, and Al Worden, being selected, plus Hank Hartsfield under consideration for MOL, together with Joe Engle, TK Mattingly and Ed Mitchell, who were not in 64C but were at Edwards at the time, celebrations livened the evenings prior to their departure for Houston.

The flying credentials of the new group were split about 50/50 between those who were operational pilots and those who had some test pilot training or experience. Don Lind, as a former Navy jet pilot and research scientist, could easily have been chosen for the scientist astronaut team in 1965 had his age not prevented it. Ed Givens was already assigned to 'space work' for the Air Force, detailed to MSC for support work on the Astronaut Maneuvering Unit (AMU) flown on Gemini. Ed Mitchell was working on the MOL program, while Joe Engle had been flying the X-15 hypersonic research aircraft for three years. In fact, as far as the Air Force was concerned, Engle was already a 'pilot astronaut' having earned his Air Force 'Astronaut Wings' by taking the research aircraft to qualifying altitudes over 50 miles on three occasions.

The qualities gained from the ARPS school, together with the rich pedigree of Edwards AFB in those early astronaut selections, were reflected in the fact that seven of the nineteen (Duke, Engle, Haise, Mattingly, Mitchell, Roosa and Worden) were former graduates of ARPS.

NASA also provided a comparison between the five astronaut groups at the time of their selections, as recorded in Table 1

In reviewing the selections to date, the new group was of course the largest chosen by NASA since 1959 and, next to the Mercury astronauts, the oldest on average of the five

Table 1 Comparison of NASA Astronauts Selections 1959-1966

Year selected	1959	1962	1963	1965	1966
Number selected	7	9	14	6	19
Average Age	34.5	32.5	30.0	31.2	32.8
Average College Years	4.3	4.6	5.6	8.0	5.8
Average Flight Hours	3,500	2,800	2,315	N/A*	2,714

*Scientist Astronaut group. Piloting experience was not required for selection.

groups. Considering they were expected to have a long wait for a flight, and hence a long career with NASA, they reflected a change in NASA policy in which experience in education was as important as the number of flying hours. This group had attained the highest average college attendance for a pilot selection, second to the academically superior scientist astronaut selection, and only slightly less average flight hours than the second intake.

This selection also brought the total chosen for NASA astronaut training to 55 in five groups since April 1959 (7+9+14+6+19), of whom 50 were currently active[7]. With three scientist astronauts completing the required jet pilot course and scheduled to return to MSC in the late summer for academic and survival training, Slayton decided to amalgamate the 19 new pilot astronauts and five remaining scientist astronauts into one large training group, for both administrative purposes and to get them through the general training program before the next (scientist) astronaut selection in 1967.

That fateful phone call

Once the group had been decided, it was down to astronaut Deke Slayton, Director of Flight Crew Operations, or Chief Astronaut Al Shepard, to inform the successful candidates by telephone one by one. There were few pleasantries displayed in these calls, as Slayton and Shepard were 'matter-of-fact' personality types. They would simply ask each candidate if they were still interested in coming to work for NASA, and on acceptance told them to be at MSC by early May.

Jerry Carr likes to recall how a phone call on April 1, 1966 changed his life forever. Along with 15 other people, he was representing the U.S. Marine Corps in an engineering design review meeting at Litton Industries Data Systems Division, in Van Nuys, California. He was there as part of a USMC evaluation of an airborne tactical data link system, when a secretary came in to inform him there was a Captain Shepard on the phone who would like to speak with him urgently. The request in itself did not surprise Carr, as he knew of a Captain Shepard at the Marine Corps Air Facility in Santa Ana, California, but he could not work out what was urgent enough to interrupt this meeting. He figured if it was that important, he had best take the call. Excusing himself from the meeting, he went to a nearby phone in the same room, fully expecting to hear the young voice of his fellow Marine in Santa Ana. But it was not *that* Captain Shepard who was on the other end of the phone. To Carr's surprise, it was Commander Alan B. Shepard, Jr., America's first astronaut to fly in space, calling from Houston to inform him of his selection to the astronaut program.

Suddenly feeling the focus of the people around him, Carr was looking back at fifteen sets of curious eyes, eager for him to explain what was so important on the phone to interrupt the meeting. He was trying to contain his euphoria and was bursting to tell them, but was unable to do so until the selection had officially been announced. For the rest of the meeting, Carr recalls feeling seven feet off the ground, trying not to give away the news

---

[7] From the first group, Deke Slayton and Al Shepard were medically grounded, though both were trying to reverse that decision, while John Glenn had retired to enter politics. Ted Freeman from the third group had been killed in an aircraft accident in October 1964, and Duane Graveline from the fourth (scientist astronaut) group had resigned for personal reasons just two months after selection.

through the wide smile on his face. Later, when he arrived back home, his wife JoAnn could not believe the news and thought it an April Fool joke. But a few days later, when the official press release was issued and the local media picked up the story, the realization of what had happened began to sink in [29].

According to Charlie Duke, there was little discussion among his classmates at ARPS Class 64C about applying to NASA as astronauts, though many thought it would be an exciting career move and possibly even more dangerous than test flying at Edwards. But the fact that four of that class did end up as astronauts at NASA surprised all of them.

MORE FOR MOL

Concurrent to the 1965/1966 NASA selection process, a second group of MOL astronauts was being sought by the USAF. Dual applications were allowed, though for military personnel the priority was to identify the best applicants for the DoD program first.

According his 2006 Oral History, Bob Crippen had also applied for NASA, but during the process found he had to choose between NASA and MOL. He ended up going with MOL, because he knew that "NASA had more astronauts than they knew what to do with," and that the Apollo program had not yet started and was already having some of its flights cancelled. He thought his best opportunity to fly was with MOL.

In his 2002 Oral History, Gordon Fullerton stated that he also applied both for NASA and MOL, but was placed in the USAF MOL pool and progressed along that avenue.

Likewise, Hank Hartsfield applied for both programs, but was told by his ARPS classmates to stick with NASA only, because if he applied for both he would be routed to MOL. Eventually he was, only making it to NASA three years later, after most of his classmates had already joined the agency and were scheduled to fly on Apollo.

Over 500 USAF pilots were screened at Randolph AFB Personnel Center for the MOL and/or NASA program during November 16-19, 1965, just a few days after the first group had been publicly identified. The December 1965 MOL Status Report, dated January 1, 1966, states that from these 500 names, a list of 100 nominees "in general order of merit," were submitted for consideration for astronaut duty. From that list, the Chief of Staff, USAF, nominated 16 names to NASA and 25 to the Director of MOL for further processing and final selection, which was expected to be completed by April 1, 1966. Those who were not chosen for MOL but were nominated (by the USMC) included Jerry Carr and Jack Lousma, though Bob Overmyer did finally make it to the next round. Of those who applied for MOL only, Ed Mitchell (USN) and 'TK' Mattingly (USN) were placed in a separate group, while from the dual applications, the USAF apparently 'cherry-picked' the pilots it wanted. Those who went into the NASA pool were pilots who had specifically requested that choice, including Air Force officers Charlie Duke, Stu Roosa and Al Worden. They were soon joined by Mitchell and Mattingly, who were early rejections for MOL. Though no official reason was given, they learned privately that they were "the wrong color blue," meaning they were from the U.S. Navy and not the Air Force. Mitchell was also too old for MOL selection at that time.

With the first group of MOL pilots undergoing preliminary training, the selection of the next group progressed in parallel with the NASA selection. In fact, we now know that both the 1966 MOL-II and 1967 MOL-III groups were phases of the same process that had selected the first group. Those chosen as candidates for MOL-II were pilots who had already completed the ARPS course and were ready for astronaut training, while those delayed a year for MOL-III were a group of 'promising pilots' who were to be sent to ARPS first, prior to their formal announcement to the MOL team.

The final 25 candidates for MOL were screened medically at Brooks AFB, specifically for MOL, from January 31 through February 4, 1966, in between and overlapping the medicals for those candidates applying to the NASA astronaut program.

The 25 were:

January 31	Capt. James A. Abrahamson, USAF
	Capt. Charles P. Cabell, Jr., USAF
	Capt. Brendan P. Foley, USAF
	Maj. Robert T. Herres, USAF
	Capt. Wendell R. Hull, USAF
February 1	Capt. Charles G. Fullerton, USAF
	Capt. Eldred D. Merkl, USAF
	Capt. Donald H. Peterson, USAF
	Capt. Leslie J. Pruitt, USAF
February 2	Capt. Robert F. Overmyer, USMC
	Capt. Karol J. Bobko, USAF
	Lt. Robert L. Crippen, USN
	Capt. Alan L. Devereaux, USAF
	Capt. Henry W. Hartsfield, Jr., USAF
	Capt. Gerald T. Morris, USAF
February 3	Capt. Spence M. Armstrong, USAF
	Capt. Thomas J. Davey, Jr., USAF
	Capt. Jimmy D. Kempton, USAF
	Capt. Robert H. Lawrence, Jr., USAF
	Capt. Gervasio Tonini, USAF (2nd time)
February 4	Capt. John W. Dettmer, USAF
	Capt. Gary T. Smith, USAF
	Capt. Joseph P. Waters, USAF
	Capt. James F. Humphries, Jr., USAF
	Capt. James R. Stanley, USAF

From this evaluation, a shortlist of twelve was chosen. The Air Force planned a two-phase selection, with six who had already graduated ARPS reporting in the summer of 1966 and assigned directly to MOL training, and a further six in the spring of the following year after they had attended – and hopefully graduated from – ARPS. As reported in the MOL Monthly Status Report for April 1966 (dated May 6, 1966), the selection board had completed the final screening and recommended five (not six) names to the Director of MOL. In the group were three from the USAF, one U.S. Navy and one USMC. "It is anticipated that an announcement of the selection will be made in the next month or two," the status report commented. It was expected that a press conference in Los Angeles would be arranged to publicly announce the new group and that they would be assigned to the MOL Systems Office that summer, with advance MOL training scheduled to commence at ARPS in November 1966.

MOL-II Group Photo (L to R): Robert Crippen, Robert Overmyer, Karol Bobko, Gordon Fullerton and Henry Hartsfield.

MOL-II selection

A press conference held at Space Systems Division Headquarters, on June 17, 1966, served as the public announcement naming the five men who made up the second class of MOL astronauts. All former graduates of ARPS, the five were:

Capt. Karol J. ('Bo') Bobko, 28, USAF (b. December 23, 1937, New York City, New York)
Lt. Robert L. ('Crip' or 'Bob') Crippen, 28, USN (b. September 11, 1937, Beaumont, Texas)
Capt. Charles G. ('Gordo') Fullerton, 29, USAF (b. October 11, 1936, Rochester, New York)
Capt. Henry W. ('Hank') Hartsfield, Jr., 32, USAF (b. November 21, 1933, Birmingham, Alabama)
Capt. Robert F. ('Bob') Overmyer, 29, USAF (b. July 14, 1936, Lorain, Ohio)

There was very little coverage of the announcement, with only ten newsmen in attendance including photographers, and no national news coverage, unlike the NASA announcement two months previously. This was intended as a low-key event due to the nature of the program and again this was achieved, with just light exposure in the Los Angeles local news. This was probably because there were no native Californians in this group, and only hometown news services gave the announcement any serious treatment [30].

The first USAFA graduate astronaut

In the U.S. Air Force Academy's weekly newspaper *Falconer* for 24 June 1966, it was proudly announced that, "For the first time an Academy graduate has been selected to participate in a space flight program. Capt. Karol J. Bobko, a member of the Academy's first graduating class, is one of five more pilots picked for assignment to the Manned Orbiting Laboratory (MOL) program, bringing the total number of officers assigned to this project to 13. Each of the newly-assigned officers will undergo 13 days of extensive space flight training. The five new pilots were selected from a group of 25 finalists screened out of more than 500 Air Force, Navy and Marine applicants. Their average age is 30.2 years compared with 32.5 years for the first group. Included in the group were three Air Force pilots and one each from the Navy and Marines" [31].

Another honor came his way when Bobko, then working in the MOL program, was voted by the Jaycees (U.S. Junior Chamber of Commerce), as an Outstanding Young Man of America for 1967. He was one of five USAFA graduates selected. The award was part of an annual biographical compilation of around 10,000 outstanding men across the country. Doug Blankenship, chairman of the Jaycees selection board, informed Capt. George Hines from the USAF Association of Graduates of Bobko's inclusion, and he in turn sent Bobko a letter of congratulations on behalf of the association.

Gordon Fullerton began hearing word about an exciting new Air Force prospect called the Manned Orbiting Laboratory while attending the Industrial College of the Armed Forces: "Space flight was just sort of becoming a possibility. The word 'astronaut' I hadn't heard of prior to this, until it started showing up in the papers. And so that sounded pretty cool, and I applied for [both] NASA and the Air Force [MOL] program, so that I'd take either one. There were selection boards convened for both." He happened to try out with the Air Force first, and after a lot of long, involved processes, was selected in the second group of crew members for the Manned Orbiting Laboratory [32].

The MOL contingency selections

Those who had not completed ARPS were Abrahamson, Cabell, Foley, Herres, Merkl, Peterson, Morris, Kempton, Lawrence, Dettmer, Smith and Waters. From these, seven were made 'contingency selections' and enrolled in the ARPS Class 66B. They were Abrahamson, Dettmer, Herres, Lawrence, Merkl, Peterson and Waters.

This decision did not go down well with the Test Pilot School selection board, having already chosen seven other pilots for Class 66B who would now be displaced by the seven MOL-III candidates. In reviewing the ARPS class, it is interesting to see how they fared during the course and in selection to MOL. Don Merkl ranked first at ARPS, but was not selected, followed by Abrahamson, Herres, Peterson and Waters, who was also not selected. Sixth in the final placing and also overlooked for MOL was Ronald Yates, USAF (who later attained the rank of a four-star general). Robert Lawrence, who was chosen in the third MOL group, finished bottom of the ARPS class, which was a surprise to some as he was thought to be an excellent pilot. Don Merkl had flown with Lawrence many times and was also of that opinion, considering Lawrence better than himself. But as with many of the ARPS students, Lawrence often delivered a poor performance when it came to checkout rides. Dettmer actually 'washed out' of ARPS. Waters, too, was 'un-selected', for reasons that are still not clear, and left the program. Tragically he was killed, aged 40, on October 16, 1972, in the crash of his F-4 at Edwards AFB.

Just prior to undergoing the final selection board in June 1967, the group returned to Brooks for a series of shorter re-tests. In the first round of examinations, a potential problem was found with Merkl's eyesight, recording 20/25 in one eye. Despite this, the selection board approved him for ARPS, telling him that the issue would have no effect on his eligibility to progress further in the MOL selection process. In the second round of examinations, the same doctor could find no change in Merkl's eyesight and suggested that if it was good enough to get him into the program in the first place, it should not present a problem this time around. It was not to be. Back at Washington, the group was told they would be presented to the selection board in alphabetical order. To their surprise, Merkl was suddenly summoned to General Russell Berg's office to be given the dreaded 'good news/bad news' bombshell. The bad news was that his eyesight situation had indeed disqualified him from further participation in MOL and that he would not be selected. However, in recognition of his excellent service record to that date, the 'good news' was that Merkl was offered the opportunity to be a technical advisor. He turned it down and was so disappointed that he tried to resign from the Air Force, but in the event retained his commission.

Years later, Merkl told Michael Cassutt what happened after he returned to the waiting room to inform his colleagues why he would no longer be involved with the program. Jim Abrahamson, always competitive, immediately joked that at least the odds for the rest of them had improved, to which Herres told him to 'knock it off'. Upon reflection, this must have played on Abrahamson's thoughts, because some years later he hired Merkl to work for him in two different jobs in Systems Command; on the F-16 program and in a senior staff position [33]. After leaving the MOL program, Merkl became an instructor at ARPS and would play a key role in the fate of another MOL contingency selectee, later that same year.

The declassified MOL DORIAN files include a May 1967 note from General Ferguson, which states there were in fact 8 contingency selectees. In further research, Michael Cassutt determined that James F. Humphries Jr., was the most likely to fulfill this role, as he was the only candidate to undergo medical tests at Brooks while still a student at ARPS and actually graduated the school ahead of Dettmer.

The final selection

Officers of the MOL Astronaut Selection Board met during May 11-12 to consider eight additional candidates for a third group to join the program. The eight were all that remained from the original 25 nominated in January 1965, and five of them were chosen to join the program in June 1967. The selection was expected to be completed by the end of May, with a public announcement of the group by June [34]. From those meetings, a total of four (not six) officers were selected, though their identities remained 'sensitive information' until a public release was made.

MOL-III Group Photo (L to R): Robert Herres, Robert Lawrence, Donald Peterson and James Abrahamson (Courtesy Space Facts).

On June 30, 1967, Maj. Robert Hermann, USAF, of the MOL Program Office, announced the four new astronauts who made up the third group. The event was described as a 'low-key' introductory press conference in Los Angeles. Their training was expected to commence that September [35]. The four men named were:

Maj. James A. Abrahamson, 34, USAF (b. May 19, 1933, Inglewood, California)
Lt. Col. Robert T. Herres, 34, USAF (b. December 1, 1932, Denver, Colorado)
Maj. Robert H. Lawrence Jr., 31, USAF (b. October 2, 1935, Chicago, Illinois) and
Maj. Donald H. Peterson, 33, USAF (b. October 22, 1933, Winona, Mississippi)

For Don Peterson, it was "a good fit" at the time, even though he admits "it was a very highly classified program. Essentially, it involved a couple of things that I had experience with. One was flying. They wanted pilots. Also, it involved technical intelligence, and I had three or four years of background in technical intelligence" [36].

A fourth astronaut class for MOL?

For some time, there have been suggestions that a fourth MOL class was being planned when the program was terminated in 1969. However, there has been very little evidence that such a selection was intended or planned for. Had the program continued, then the USAF would have been obliged to choose a fourth group of astronauts as members of the first group retired. These plans were very vague and other events overtook any thought of a new selection. In 1969 when MOL was cancelled, fourteen of the original seventeen men were still active (Adams and Lawrence were deceased, and Finley had returned to the U.S. Navy) for the ten seats on the five manned MOL missions planned. Clearly, the MOL program office had more astronauts than it had missions or seats for.

END OF AN ERA

In a little over ten years, NASA had selected 73 men (56 pilots and 17 scientists) for the astronaut program. This included seven transfers from the 17 military pilots the USAF had originally selected for their MOL program. These men made up the core of the NASA Astronaut Office for three decades, from the single seat Mercury capsule in the early 1960s to the multi-seated Space Shuttle through to 1990. The pioneering era of American manned spaceflight featured Mercury, Gemini and Apollo (including the Skylab and ASTP missions), flown in the fourteen years between 1961 and 1975. At a time of military conflict in South East Asia and growing social unrest at home and abroad, the NASA Class of 1966, together with the 17 chosen for MOL, forged a new era in human spaceflight towards extended missions, scientific discoveries and pioneering technology.

When the MOL was cancelled in 1969, none of the fifth NASA group or MOL astronauts had actually flown in space[8]. But from the following year, this would change. From 1970 through 1990, members of the fifth and seventh selections regularly crewed Apollo and Shuttle missions, providing the link between the original astronauts of Mercury and Gemini and the current crews occupying the International Space Station. Indeed, many of the former astronauts of 1966 and 1969, after leaving active astronaut status, went on to leading management roles within NASA, the military or industry.

For the nineteen new NASA astronauts, having been successful in their selection for spaceflight training, their preparation would come to include countless hours in classrooms and simulators – far more than they would ever log in space – starting with familiarization with the Gemini program and training on Apollo hardware, before receiving their first flight assignments. If they thought being selected to the space program was difficult, they were about to find out that training to fly in space and actually securing a seat to achieve their ambition was going to be much harder.

[8] This, of course, discounts Joe Engle's three X-15 'astro-flights' prior to joining the NASA astronaut program.

References

1. *The Bohannon Hypothesis,* John B. Charles, Focus on Aerospace Medicine History, Aerospace Medicine and Human Performance Vol. 86, No. 11, November 2015, pp. 1010-1011
2. NASA News: MSC-65-73
3. Monthly Status Report: September 1965, dated October 7, 1965
4. MOL Status Report: December 1965, dated January 1, 1966
5. Albert Crews, Jr.: interview by Rebecca Wright for NASA's Oral History Project, Satellite Beach, Florida, August 6, 2007
6. Acknowledgments to Mike Cassutt for the original research and for detailing his findings, in various emails, regarding the selection of MOL candidates
7. Email from Mike Cassutt: January 12, 2009
8. NASA News Release: MSC 65-79
9. *NASA Recruiting Additional Pilot Astronauts*: Space News Roundup, MSC Houston, Texas, Vol. 4, No. 24, September 17, 1965, p. 1
10. ***Around the World in 84 Days***, David J. Shayler, Apogee Books, 2008
11. ***Flying Higher and Faster***, Vance Brand, Mira Digital Publishing, 2015, p. 45
12. ***To Rule the Night***, James B. Irwin with William A. Emerson Jr., A. J. Holman Company, 1973, pp. 192-196
13. ***Way of the Explorer***, Edgar Mitchell with Dwight Williams, Putnam Publishers, 1996, pp. 20-23
14. Paul Weitz: interview by Rebecca Wright for NASA's Oral History Project, Flagstaff, Arizona, March 26, 2000
15. ***Falling to Earth***, Al Worden with Francis French, Smithsonian Books, 2011, p. 55
16. Charles Duke: interview by Doug Ward for NASA's Oral History Project, Houston, Texas, March 12, 1999
17. Joe Engle: interview by Rebecca Wright for NASA's Oral History Project, Houston, Texas, May 24, 2004
18. Janet Evans: Apollo 17 40th anniversary event, San Diego Air & Space Museum, California, December 18, 2012
19. NASA News Release: MSC 66-1, January 6, 1966
20. *Evaluation Begun of Would Be Astronauts*: Space News Roundup MSC, January 21, 1966, p. 3
21. Historical documentation of the Gemini Program: T.H. Poe, Chief Administration Support Branch, Aerospace Medicals Sciences Division, USAF School of Medicine, Brooks AFB, Texas, filed in NASA History Office Source Files, Project Gemini Collection, General Subject Files, Box 382, which, in 2000, was located at NARA, Fort Worth, Texas; also, *America's Almost Astronauts*: The astronaut applicants Class of '62 and '63, David J. Shayler, *Spaceflight* Vol. 43, No. 3, March 2001, pp. 114-117
22. ***Don Lind, Mormon Astronaut,*** Kathleen Maughan Lind, Deseret Books, 1985, pp. 59-66; also, AIS interview with Don Lind, April 2000
23. ***Don Lind, Mormon Astronaut***, 1985

24. ***Smoke Jumper, Moon Pilot: The remarkable life of Apollo 14 astronaut Stuart Roosa***, Willie G. Moseley, Acclaim Press, 2011, p. 90
25. ***Moonwalker***, Charlie & Dottie Duke, Oliver Nelson Publishers, 1990, pp. 75-76
26. ***But for the Grace of God***, William R. Pogue, Soar with Eagles publishers, 2011, pp. 194-195
27. ***Deke: U.S. Manned Space from Mercury to the Shuttle***, Donald K. 'Deke' Slayton with Michael Cassutt, Forge Books, 1994, pp. 171-173
28. NASA News Release: MSC 66-22; also, *Newly Selected Group of 19 Astronauts Report Next Month for Duty*, MSC Space News Roundup, April 15, 1966 pp. 4/5
29. Ref. 10, p. 15
30. MOL Monthly Status Report for June 1966, dated July 8, 1966
31. U.S. Air Force Academy *Falconer*, article "*USAFA Graduate Selected for Space Flight Program*," issue June 24, 1966
32. C. Gordon Fullerton: interview by Rebecca Wright for NASA's Oral History Project, NASA Dryden Flight Research Center, May 6, 2002
33. Email from Michael Cassutt, May 13, 2005
34. MOL Monthly Status Report for March (April 5, 1967) and May (June 5, 1967)
35. MOL Monthly Status Report for June, dated July 7, 1967
36. Donald H. Peterson: interview by Jennifer Ross-Nazzal for NASA's Oral History Project, Houston, Texas, November 14, 2002

2

The nineteen

"[Choose] as many qualified guys as you can find."
Deke Slayton, Director, Flight Crew Operations,
Manned Spacecraft Center, Houston,
responding to a question from the
Group 5 selection panel.

Mindful of that instruction from Slayton, at the end of the selection process the Group 5 selection board convened to review the finalists. By March 1966, the list of candidates had narrowed to 35 and was then further reduced to 19. Deke Slayton, the head of the selection panel, looked through the list and then made a considered decision – he would take the lot. He had determined that they would be needed to fulfil NASA's long term goals at that time, because of plans for ongoing lunar and Earth-orbiting missions. But he knew, deep down, that cuts in funding and delays to hardware meant that none of them would fly for some time, perhaps many years, and some might not get the chance to fly at all; an instinct which proved prophetic.

With the announcement of the fifth group of NASA astronauts, all 19 were immediately thrust into the public eye, with many experiencing the challenges that entailed for the first time. The group were not to receive the adulation of the 'Original Mercury 7', or even the 'Next Nine' chosen in 1962, but their new status as 'America's latest astronauts' would dramatically change all of their lives.

But behind the headlines and media spotlight, who were these 19 pilots? The majority had, figuratively, been rocketed from almost obscurity into the spotlight of the national press and into the public eye. Each had a different story to tell on their path to the Astronaut Office and each would contribute their own entry to the pages of early American spaceflight history. [1]

D.J. Shayler, C. Burgess, *The Last of NASA's Original Pilot Astronauts*,
Springer Praxis Books, DOI 10.1007/978-3-319-51014-9_2

VANCE D. BRAND

In December 1990, as Commander of STS-35/Astro 1, Vance Brand became the last active member of the first era of NASA's astronaut program to fly in space[1]*. In an illustrious astronaut career, Brand had performed numerous support and back-up roles during Apollo and Skylab, before flying his first mission in July 1975 as Command Module Pilot on the last Apollo ('18'), which docked to the Soviet Soyuz 19 spacecraft and which was heavily promoted as the first international spaceflight. Choosing to remain at NASA to fly on the Space Shuttle, he commanded the first operational mission (STS-5) in 1982, and the first mission to test fly the Manned Maneuvering Unit (STS-41B) in 1984, as well as STS-35. His final flight not only ended the first decade of Shuttle orbital operations, but also brought to a close the era of American spaceflight by members of NASA's 'original career astronauts' chosen between April 1959 and August 1969.*

Born in Longmont, Colorado on May 9, 1931, Vance DeVoe Brand was the son of Rudolph William Brand and the former Donna DeVoe. "It was a long time ago," he mused to the authors. "Back then, we mainly had biplanes and aviation was very young, and I know the first airline hostess or stewardess flew a year after I was born. When I was about five years old, my father got me a ride in a Ford Tri-Motor and the two of us went up in that. That sort of thing, along with the feeling at the time that aviation was very young and exciting, got me interested." [2]

After graduating from Longmont High School in 1949, Brand took on studies at the University of Colorado, leaving four years later with his bachelor of business degree on June 6, 1953. Over the next four years, he served in the Marine Corps as an infantry officer: "But I didn't really decide to make aviation a career until I was about probably 23 years old and I was stationed for a time at Marine Corps Air Station Cherry Point, in North Carolina. I saw the Navy version of the F-86 *Sabre* jet, called the *Fury*, taking off while I was having breakfast near the airfield and I just decided I'd like to do that. And so there wasn't any rationale or reasoning that went into that decision; it was purely emotional that I'd like to fly. And later, when I did get into flying as a jet pilot, the first humans went into space and I thought that would be really interesting, because that's flying higher and faster."

Brand completed flight training in 1955 as a naval aviator, ahead of being assigned a 15-month tour of duty in Japan as a jet fighter pilot. Following his release from active duty, Brand returned to the University of Colorado, graduating on June 2, 1960 with his second bachelor's degree, this time in Aeronautical Engineering. He then took on work with the Lockheed Aircraft Corporation, initially as a flight test engineer on the Navy's P-3A *Orion* aircraft. Throughout the period 1957-1964, he would also serve as a USMC Reserve pilot and as a fighter squadron pilot in the Air National Guard. In 1962, Lockheed sent Brand to the U.S. Naval Test Pilot School at Patuxent River, Maryland, where he studied and flew with Class 33, graduating in February 1963. Lockheed encouraged him to apply for NASA's third astronaut group later that year, but even though he made the final 34, he was not selected.

Brand would remain with Lockheed at Palmdale, California, as an experimental test pilot on Canadian and West German F-104 programs. In 1964, he received his master's degree in Business Administration from the University of California, Los Angeles.

[1] In October 1998, at the age of 77, veteran Mercury astronaut and U.S. Senator, John H. Glenn, Jr., returned to space in a temporary role as a Payload Specialist on STS-95, retiring shortly afterwards. He had originally left the Astronaut Office in January 1964 to enter politics.

When finally selected to NASA's Group 5 astronauts as a civilian pilot on April 4, 1966, he was working for Lockheed at their West German F-104G flight test center in Istres, France, as an experimental test pilot and leader of a Lockheed flight-test advisory group. Additionally, he still held a commission as a major in the U.S. Air Force (active) Reserve until 1964. He then served for the next decade in the USAF (inactive) Reserve, until 1974 [3].

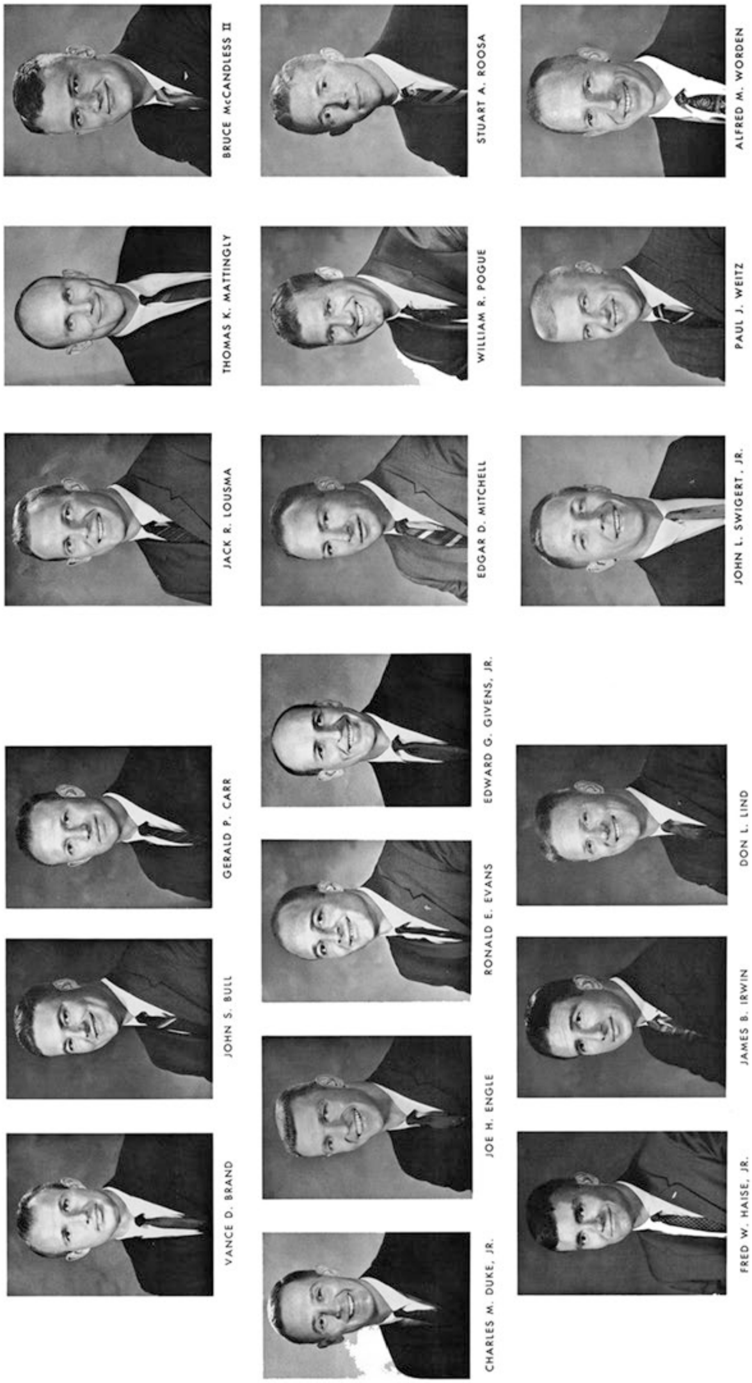
JOHN S. BULL

When NASA announced its fifth cadre of astronauts in April 1966, listed among those 19 names was Lt. John Bull, an experienced and highly talented U.S. Navy test pilot. Sadly, his tenure with NASA would barely last two years, before a chronic pulmonary disease caused his reluctant withdrawal from the astronaut corps. Had he not lost his chance to fly for NASA, he would have been high on the list to walk on the ancient surface of the Moon during Project Apollo.

John Sumter Bull was born in Memphis, Tennessee, on September 25, 1934, to Ruth and Charles Mayrant Bull, and younger brother to Charles and Lori. His father was an engineer. The family would later be completed with another sibling, named Steve. Going back nearly three centuries in history, the Bull and Mayrant families were among the first settlers of South Carolina, and the family lineage includes such luminaries as William Bull, a governor of South Carolina; General Thomas Sumter, a hero of the American Revolution (and the source of John Bull's middle name); and Captain John Mayrant, Jr., who served with distinction alongside the legendary John Paul Jones, founder of the U.S. Navy.

As a child, John and his older brother Charles loved playing with model airplanes – a passion that also passed on to young Steve [4]. This interest in airplanes took root and stayed with Bull all his life, providing the spur that put him on the path to becoming a naval aviator. After attending primary and secondary schools in Memphis (and joining the Boy Scout movement), he graduated from that city's Central High School in 1952 [5].

Bull received his bachelor of science degree in Mechanical Engineering from Rice University in 1956 and also completed one year of study towards his master's degree. He entered active duty with the U.S. Navy in June 1957 and, upon receiving his commission, began initial flight training as a Naval Aviation Cadet at Pensacola, Florida, later receiving advanced jet transition training at NAS Kingsville, Texas. He was awarded his coveted Wings of Gold as a naval aviator in 1958 and, from March 1959 to November 1960, flew the McDonnell F3H *Demon* while attached to Fighter Squadrons VF-121 and VF-92. Bull would then operate the *Demon* and F-4 *Phantom II* jets when assigned in 1962 to VF-114, based at NAS Miramar, California. Altogether, he served three squadron tours on Western Pacific (WESTPAC) cruises aboard the carriers *USS Ranger* (CV-61), *Hancock* (CV-19) and *Kitty Hawk* (CV-63) [5]. Lt. Bull graduated from the U.S. Naval Test Pilot School at Patuxent River, Maryland, in February 1964, having been named the "outstanding student" of his class. He was then assigned as a project test pilot in the Naval Air Test Center's Carrier Suitability Branch, also located at Patuxent River [5]. In June that same year, he married Nancy Laraine Gustafson of Seattle, Washington.



NASA's fifth astronaut selection, April 1966, "The Original Nineteen."

On August 31, 1965, the engines on Bull's Douglas A-4 *Skyhawk* failed on take-off from NAS Lakehurst, New Jersey, and he crashed into a marsh a few hundred yards off the end of the runway. Fortunately, a helicopter crew was practicing instrument approaches and saw the A-4 go down. They flew to the scene, where Bull had scrambled free of the downed jet. After climbing into their rescue sling, he was hoisted clear of the accident scene before being transported to the station hospital. It was one of three aircraft incidents in which he would be involved while flying with the U.S. Navy. [6]

At the time of his selection by NASA, 31-year-old Lt. Bull had accumulated 1,634 hours of flight time; 1,424 hours of which was in jet aircraft [7]. When asked by a reporter at the press conference what he hoped to accomplish as an astronaut, he responded, "I certainly would like to be the first man on the Moon. That's the big one!" [8]

GERALD P. CARR

Jerry Carr, Commander of Skylab 4, the third and final manned mission of the series, jointly held the world spaceflight endurance record of 84 days for four years, until it was surpassed in March 1978 by the first resident crew of Salyut 6, who set a new record of 96 days. However, along with his crew – fellow Group 5 astronaut Bill Pogue and Group 4 scientist astronaut Ed Gibson – he retained the U.S. manned spaceflight endurance record for 20 years, until Norman Thagard's four-month tenure aboard the Mir station in 1995. It could have been so very different for Carr, who was originally in line to fly as Lunar Module Pilot on Apollo 19 until the flight was cancelled in September 1970. Having lost the chance to become the sixteenth man to walk on the Moon, he was reassigned to Skylab and, in hindsight, Carr feels fortunate to have commanded the longest orbital flight in history to that point. According to German rocket designer and space visionary Wernher von Braun, Skylab 4 provided a vital step in understanding long term space flight and was an early milestone in the ultimate conquest of the solar system.

Gerald Paul Carr, better known as Jerry, was born in Denver, Colorado, on August 22, 1932, but has always considered Santa Ana, California, to be his home town. Possessing an inquisitive mind from a young age, he became interested in mechanics and technology, and recalls developing an interest in aviation at around the age of fourteen, soon after the end of World War II. It was an interesting time to be a young boy, when a lot of new and experimental aircraft were traversing the skies over southern California. Together with one of his friends, he would cycle the 14 miles down to Orange County Airport every Saturday, where the Martin Aviation Company housed several older Taylorcraft airplanes. They got to know some of the people working there and were soon washing airplanes all day, for which they were repaid with an exhilarating 20-minute flight in one of the Taylorcraft.

An active and enquiring youth, Carr played football in high school and also joined the Boy Scout movement, eventually becoming an Eagle Scout with several Palms. In his senior year at high school, despite a keen desire to join the U.S. Marines as a pilot, he received an appointment to the U.S. Naval Academy at Annapolis, Maryland, and was also accepted into the Naval ROTC program, as he explained:

"The thing that got me to a place where I chose the Naval ROTC was my commanding officer of the Naval Reserve squadron there. Here I was, a high school senior with two opportunities: I could go to the Naval Academy, or I could go to the Naval ROTC at the college of my choice. At the time, I had an opportunity to go to USC (University of Southern California) [or] UCLA (University of California, Los Angeles) … so I went in to my commanding officer, told him of my opportunities and asked for his advice. He was a Naval Academy graduate, but had left the regular forces and was a reserve officer at the time. He thought about it for a minute and he said, 'Well … if you really want to go Navy, then probably the thing to do is to go to the Naval Academy, but … if you intend to go Marine, then you should give serious consideration to the Naval ROTC. The reason why is because in the Marine Corps, they don't care where you came from, whether you're an Academy graduate or not'." [9]

Carr decided to accept his CO's advice and elected to take an appointment to the Naval ROTC at USC, although his eventual goal was to join the U.S. Marines and undertake pilot training. He began his college years as a math major, but soon realized it was too academic for him, and that he really wanted to study engineering, so he shifted into the university's mechanical engineering program.

Through the ROTC program, he used to travel to the Los Alamitos Naval Air Station, where he became responsible for looking after a Grumman F6F *Hellcat*. His responsibility was to clean up the aircraft, ensure its gas and oil were topped up and that it was in good shape, then start it up and let the *Hellcat* run and warm up. He was made commander of the ROTC battalion in his senior year and graduated from USC with honors and his bachelor's degree in Mechanical Engineering.

Carr would become a 2nd Lt. in the U.S. Marines in June 1954, although he knew he could not go directly from university to flight training. That same month, on June 20, he married his first wife, the former JoAnn Ruth Petrie. As he waited for an assignment to flight training, he was sent to the U.S. Marine base at Quantico, Virginia, where he spent the rest of that year undergoing basic officer and postgraduate training. In January the following year, he was finally sent for flight training to Pensacola, Florida.

Following initial flight training, he received advanced training at Kingsville Naval Air Station, Texas, gaining his aviator wings in May 1956. He was then sent to Marine Corps Air Station Cherry Point, North Carolina. "After a few weeks, I was assigned to [Marine Fighter Squadron] VMF-114, which in those days was flying the old [Grumman] F9F-8 *Cougar*. Shortly after that, about six or eight months after I joined the squadron, we were assigned the [Douglas] F4D *Skyray*." [9]

He would remain in VMF-114 for three years. The final part of his tour of duty entailed a Mediterranean cruise: "The Marine squadrons must be carrier-qualified, and we did a lot of practicing in getting ready for carrier work," he reflected. "We went aboard the *USS Franklin D. Roosevelt* [CVA-42] … It was about four months into that six-month cruise that I was informed that I had been selected for U.S. Naval Postgraduate School … so I left the ship in about August, I think it was, and reported to the Naval Postgraduate School in Monterey. I spent two years there studying aeronautical engineering, and that was really murder, because it was four years of college crammed into two. What they did is they took out all of the English and the economics and the history and it was just all math and physics and aeronautical engineering. It was a tough, tough course." [9]

Having completed his postgraduate training, Carr was then sent to Princeton University to pick up his master's degree in Aeronautical Engineering, which involved studying stability and control of aircraft. After receiving his degree on June 12, 1962, he served with Marine All-Weather Squadron 122 (VMF-122) until 1965, flying the F-8 *Crusader* in the United States and then a 12-month Far East posting with the squadron at the Naval Air Station Atsugi in Japan.

On his return to the United States, Carr was assigned to the Marine Corps Air Facility at Santa Ana, California. Due to his background as an interceptor pilot and with aeronautical engineering behind him, he was posted to an outfit that was automating a flight intercept system, known as the Tactical Air Data System. While there, he heard that NASA was preparing to select a new group of astronauts, and it was suggested that any marine who was interested should send an application to the Commandant of the Marine Corps.

CHARLES M. DUKE, JR.

Lunar Module Pilot of Apollo 16 and the 10th man to walk on the Moon, Charlie Duke can proudly trace his family heritage back to a Virginia ancestor, Col. Philemon Berry Waters, who had fought alongside and befriended future President George Washington during the American Revolutionary War. Duke only made one flight into space, but he is also remembered for another historic mission. He played a key role in the drama which unfolded on July 20, 1969, as Apollo 11's LM Eagle *approached the lunar surface. Duke was on duty as Capcom for the descent and landing, and his distinctive southern drawl announced a successful lunar landing with the flustered words, "Roger, … Tranquility, we copy you on the ground. You got a bunch of guys about to turn blue. We're breathing again. Thanks a lot!"*

Charles Moss Duke, Jr., was born on October 3, 1935, in hospital in Charlotte, North Carolina, the first of identical twins born to Charles and Willie (Waters) Duke, with William – named for his mother – entering the world six minutes after him. They may have been twins, but Charlie and his brother Bill later took different paths through life. Bill (who died in the summer of 2012) became a physician in Lancaster, South Carolina, and once revealed that he was not at all fond of flying, unlike his brother. A sister named Betsy would join the two boys 14 years later, to complete the Duke family.

The family moved to a house on Market Street in Lancaster, South Carolina. Charles Duke Sr. sold insurance from a storefront on Gay Street, while his wife Willie ran a dress shop. It was the middle of the Great Depression and, like many other families, the Dukes took in boarders to make a few extra dollars.

Following the Japanese attack on Pearl Harbor, the boys' father volunteered for the Navy and, after training, was sent to the South Pacific. Meanwhile, Willie took her sons to live with her mother in Johnston, South Carolina, where the boys took their elementary education and attended regular church services. As well as outdoor activities, young Charlie loved going to the movies, enjoying westerns but thrilling at war movies such as *Flying Tigers*. He and his brother would build small model airplanes and fly them off the second-floor porch.

Their father returned safely from overseas in 1944, and at the end of the war the following year, the family moved back to Lancaster, South Carolina, where the boys attended Lancaster High School. One day as a teenager, Charlie saw a movie that was set in West

Point, called *The Long Grey Line*, and he came to the decision to join a military service. "Because of my dad's experience in the Navy, I decided I wanted to attend the Naval Academy at Annapolis, Maryland." [10]

Charles Duke at the U.S. Naval Academy.

He then carefully plotted a course toward that goal. At 16 years of age, he was enrolled at a military prep school, the Admiral Farragut Academy in St. Petersburg, Florida, graduating as a valedictorian in 1953. He then won an appointment to the Naval Academy. "They gave me a couple of rides in an open-cockpit, bi-wing seaplane called the N3N *Yellow Peril* and I was hooked from that moment on." [11]. He would graduate from the academy on June 7, 1957, with his bachelor's degree in Naval Science.

Although he had been ranked in the top ten percent of his academy class, Duke was dismayed when he found himself washed out of the naval aviation program. "The doctors found a slight astigmatism in my right eye," he recalled. "It was disqualifying for naval aviation, but not the Air Force." [12]. Duke took his commission as a 2nd Lt. in the U.S. Air Force, and that's where he truly fell in love with flying. He received his initial training at Spence Air Base, Georgia, and finished basic flight training at Webb Air Force Base (AFB), Texas, in 1958, as a distinguished graduate. He then completed his advanced training, flying North American F-86L *Sabre* aircraft out of Moody AFB, Georgia.

After serving three years with the 526th Fighter Interceptor Squadron (the 'Black Knights') at Ramstein Air Base, Germany, Duke decided, for the benefit of his career, to go to graduate school. He volunteered to study for his master's degree at North Carolina State University, but when he was told this was not available at that time, he won an Air Force scholarship to the Massachusetts Institute of Technology (MIT), where he undertook studies for his master's degree in Aeronautics and Astronautics.

"I didn't even know there was a degree like Aero and Astro, but since it was the only one offered I said, 'Sure, I'll take it.' It was a difficult decision to leave the cockpit and go back to school. I really loved to fly and knew that at MIT, I would be a full-time student and basically out of flying. If lucky, I'd be able to get a couple of rides a month in a T-33 out of Hanscom Field [Massachusetts], but that would be it.

"I also didn't know what assignment I would get when I completed my degree – whether I'd ever get back in the cockpit or not. But my love for flying was overcome by my desire to get ahead in my career. Even though I was enrolling for a degree in astronautics, I didn't give a thought to the possibility of becoming an astronaut." [**10**]. He would graduate from MIT with his master's degree in 1964. While there, he also met and married Dorothy Meade Claiborne of Atlanta, on June 1, 1963.

Subsequent to his time at MIT, Duke received a much-desired transfer to one of the most exciting places an ambitious Air Force pilot could hope for – the Aerospace Research Pilot School (ARPS) in California. "Some friends told me about the test pilot school at Edwards AFB, California … I applied, realizing that my qualifications were at the barest minimum. I felt like my prospects of getting selected were either slim or none. But miraculously, a few months later, the orders came down assigning me to the class of '64C … to begin in August 1964. I was elated. I was going to be able to continue my flying in the hottest jets and also be able to use my engineering training. It was then that I began to think that maybe I had a chance of becoming an astronaut." [**10**]

Upon graduation from the ARPS in September 1965, Duke remained at Edwards as an ARPS instructor, teaching control systems and flying such high-performance aircraft as the McDonnell F-101 *Voodoo*, the Lockheed F-104 *Starfighter* and the Lockheed T-33 *Shooting Star*.

JOE H. ENGLE

Of all the NASA astronauts selected to date (2016), Joe Engle was the first and, so far, only one to fly into space before joining the civilian space agency, in 1966. Three times in 1965, he flew the hypersonic rocket-powered North American X-15 to an altitude greater than 50 miles, then officially recognized by the U.S. Air Force as marking the boundary of space, thus qualifying Engle for USAF astronaut wings. His time with NASA would see him command one of the two Shuttle Approach and Landing Test crews in 1977 and later, in 1981 and 1985, lead two very different Shuttle missions to success. He was also to feel bitter disappointment, having being chosen to fly to the Moon as LMP on Apollo 17 and given *the chance to become the 12th man to walk on the Moon, only to be removed from the last Apollo lunar flight in favor of geologist scientist astronaut Jack Schmitt. He remains the only pilot to have flown two winged vehicles to and from space (X-15 and the Shuttle).*

Joe (not Joseph) Henry Engle was born on August 26, 1932, to Abner Ethan and Margaret (née Beaver) Engle, in the farming community of Chapman, Kansas. He took his early education at Chapman Elementary School, but even in his youth, Joe found no future appeal in becoming a farmer like his father. Instead, he found fascination in the stories of famous pilots and airplanes and, like so many young people of that time, began building model aircraft. He also joined a group of like-minded boys in the Junior Flying Tigers Club of Chapman, with meetings held in a friend's basement. When he was nine years old, Japanese forces attacked Pearl Harbor, unexpectedly ushering the United States into war.

Newspaper and magazine reports of American combat pilots only heightened his interest in aviation, but while he was still attending Dickinson County High School, the war in the Pacific came to an end. Like his father and sisters, Engle would have enrolled at Kansas State University in nearby Manhattan, until he discovered that that division of KSU did not have an aeronautical engineering degree program, which he wanted to tackle, so he headed east to enroll for his college years at KSU's Lawrence campus. While there, he joined the U.S. Air Force's Reserve Officer Training Corps (ROTC), and also met his future wife, Mary Catherine Lawrence, from Mission Hills, Kansas. Engle would be awarded his bachelor of science degree in Aeronautical Engineering in 1955, and he and Mary were married the following year.

Having earned a commission through the ROTC program at college, Engle began his active service in the Air Force on March 14, 1956 and began flight training the following year. After receiving his pilot's wings, he served as a fighter pilot, flying North American F-100 *Super Sabre* jets with the 474th Fighter Day Squadron (later re-designated as the 309th Tactical Fighter Squadron) at George AFB, California, from 1957 to 1961. During this time, he operated on 10 extended transatlantic fighter alert sorties to Spain, Italy, Denmark, West Germany, France and England [13].

Eventually, having set his sights on one day becoming a test pilot, Engle applied to become a student at the Air Force's Experimental Test Pilot School (ETPS) at Edwards AFB, California, then under the command of legendary test pilot Col. Chuck Yeager. In 1961, he was accepted into Class 61C. Following his graduation from ETPS, Engle stayed on as a test pilot at Edwards before being assigned to a highly-advanced, seven-month course at the base on October 22, 1962, receiving space-related training and instruction with the Aerospace Research Pilot School (ARPS). He was not to know it at the time, but he was being groomed as a future candidate for the X-15 hypersonic airplane program. ARPS Class III would all graduate as highly-skilled pilot engineers in May 1963. Those graduates now became military astronaut-designees, making them available for selection as pilots to any future space research programs. Aside from Engle, three others would go on to become NASA astronauts – Charlie Bassett, Mike Collins and Ed Givens.

Joe Engle at EAFB in 1963, shortly after his selection to fly the X-15 (Courtesy USAF).

Prior to attending the ARPS, Engle had been nominated as a potential NASA astronaut by the Air Force. On April 18, 1962, NASA had announced that it was seeking applications from both military and civilian test pilots for its second astronaut group. As with the Navy and Marines, the Air Force submitted a list of suitably qualified candidates – 11 in all – for consideration. They were:

Maj. Frank F. Borman II
Capt. Michael Collins
Capt. Roy S. Dickey
Capt. Joe H. Engle
Maj. Neil P. Garland
Capt. James A. McDivitt
Capt. Francis G. Neubeck
Capt. Robert W. Smith
Capt. Thomas P. Stafford
Capt. Alfred H. Uhalt, Jr.
Capt. Edward H. White II

All of the men were fully briefed before their names were submitted to NASA, and most made it through to the next phase of the selection process. The two who missed out on proceeding further were Neil Garland and Joe Engle. However, there was more in store for Engle in June 1963, when he was assigned as a test pilot with the Fighter Test Group at Edwards. In that same month, he was officially informed that he was being transferred into the X-15 flight research program, for which he had already performed several chase plane duties. He would make his first flight in the X-15 on October 7, 1963.

As Engle related in his foreword to *The X-15 Rocket Plane: Flying the First Wings Into Space*, "The X-15 was the greatest airplane I have ever had the privilege to fly. It was an honest, beautifully handling airplane and, most of the time, a real joy to fly. It was also the most rewarding airplane I have flown, while requiring the pilot's continuous, undivided attention throughout the entire flight profile." [**14**]

However, he nearly got into serious trouble on his first flight in the rocket-powered airplane. As a test pilot, Engle had always taken his job seriously, although occasionally his exuberance took over. As related by Dennis Jenkins in his book, *Hypersonic: The Story of the North American X-15*, that happened on his first flight. "After he had completed the familiarization maneuvers, he slow-rolled the X-15. That maneuver really shocked the engineers in the control room. They did not immediately recognize it as a slow roll. They assumed the worst and thought that Joe had a control problem." As a consequence, Engle had to appear before chief project pilot Bob Rushworth, who gave him a stark reminder of his responsibility to the research program and everyone behind it. [**15**]

Between October 7, 1963 and October 14, 1965, Engle made a total of 16 flights in X-15-1 and X-15-3 (see Table 2). On his final three flights, he exceeded an altitude of 50 miles, thus qualifying him for Air Force rating as an astronaut, and he was subsequently awarded his USAF astronaut wings.

RONALD E. EVANS

Widely regarded as one of the most proficient pilots in the pre-Shuttle astronaut corps, Ron Evans had honed his skills by flying over a hundred combat missions in the Vietnam War as a captain in the U.S. Navy. As with many of his colleagues, he would go on to serve on several Apollo support crews, before flying his only mission in December 1972 as Command Module Pilot of Apollo 17, the last manned lunar landing of the program.

Ronald Ellwin Evans was born in rural St. Francis in the northwest corner of Kansas, but always considered the state's capital, Topeka, to be his home town. Born to Clarence E. (Jim) Evans and the former Marie Priebe on November 10, 1933, he attended the St. Francis Grade School until he graduated from the eighth grade. In 1947, the family moved to Topeka, where Evans became a member of the National Honor Society while at Highland Park High School, a track star, and an All-Conference football guard. He earned a bachelor of science degree in Electrical Engineering from the University of Kansas in 1956. That same year, he entered the U.S. Navy through ROTC, was commissioned an ensign at the end of the course and completed his flight training in June 1957, now designated a naval aviator. Six months later, on December 22, he married the former Janet Merle (Jan) Pollum of Topeka, Kansas. They would have two children.

Table 2 X-15 Free Flights Flown by Joe Engle 1963-1965

Engle's Free Flight	Date of Free Flight	Program Free Flight	X-15 Flown	Free Flight Time (min:sec)	Max Speed (mph/kph)	Mach	Max Altitude (feet/meters)	Engle's X-15 Records
1	1963 Oct 7	092	#1	07:37.0	2,834/4,561	4.21	77,800/23,713	1st X-15 free flight
2	1963 Nov 14	095	#1	07:46.8	3,286/5,288	4.75	90,800/27,676	
3	1964 Jan 8	098	#1	08:50.7	3,616/5,819	5.32	139,900/42,642	
4	1964 Apr 8	104	#1	09:45.7	3,468/5,581	5.01	175,000/53,340	
5	1964 May 19	107	#1	09:01.2	3,494/5,623	5.02	195,800/59,680	
6	1964 Jul 8	111	#3	09:55.9	3,520/5,665	5.05	170,400/51,938	1st flight in #3 aircraft
7	1964 Jul 29	112	#3	07:49.1	3,623/5,831	5.38	78,000/23,774	
8	1964 Sep 28	117	#3	09:34.3	3,888/6,257	5.59	97,100/29,596	Maximum speed
9	1964 Dec 10	123	#1	09:44.7	3,675/5,914	5.35	113,200/34,503	
10	1965 Feb 2	126	#3	09:58.3	3,885/6,252	5.71	98,200/29,931	Highest Mach
11	1965 Apr 23	130	#3	07:42.1	3,657/5,885	5.48	79,700/24,293	
12	1965 May 28	134	#3	09:35.6	3,754/6,041	5.17	209,600/63,886	
13	1965 Jun 16	135	#3	09:46.4	3,404/5,478	4.69	244,700/74,585	
14	1965 Jun 29	138	#3	10:32.3	3,432/5,523	4.92	280,600/85,527	1st Astro flight & highest altitude
15	1965 Aug 10	143	#3	09:51.8	3,550/5,713	5.20	271,000 /82,601	2nd Astro flight
16	1965 Oct 14	153	#1	09:17.7	3,554/5,720	5.08	266,500/81,229	3rd Astro flight

Data courtesy, *North American X-15, Owners Workshop Manual*, David Baker, Haynes Publishing, 2016

Assigned as a fighter pilot to VF-142, based at NASA Miramar, California, Evans participated in two carrier deployments to the Western Pacific aboard the *USS Ranger* (CV-61) and *USS Oriskany* (CV-44), in 1959 and 1960 respectively, flying the F8U-1 *Crusader*. From January 1961 until June 1962, he was a combat flight instructor for the F-8 aircraft with VF-124. He applied for NASA's third astronaut group in 1963 but was unsuccessful. The following year, he received his master of science degree in Aeronautical Engineering from the U.S. Naval Postgraduate School and began sea duty in the Pacific, where he was assigned to VF-51 under Commander James Bond Stockdale and flew the F8U-2NE *Crusader* from the deck of the *USS Ticonderoga* (CV-14). This was the same carrier that would later pick up his Apollo 17 crew following their journey to the Moon in 1972. During this period, Lt. Cdr. Evans was engaged in combat operations for seven months in Vietnam, flying over 100 combat missions. He was the Electronics Officer for VF-51 when notified of his selection by NASA.

EDWARD G. GIVENS, JR.

Although he missed out on selection to the first (Mercury) astronaut group in 1959, Ed Givens would finally join NASA in the space agency's fifth astronaut contingent seven years later. Tragically, fourteen months after he was selected, he was killed in a car accident. After serving on the support crew for the first Apollo mission, it is reasonable to assume he could have been assigned to a later Apollo flight crew.

Edward Galen Givens, Jr., was born on January 5, 1930 to Helen (née Jarrell) and Edward (Bill) Galen Givens, a bookkeeper in the quiet Texas farming town of Quanah. He proved to be bright scholastically and, when he reached Quanah High School, took on extra courses in order to skip a year and graduate early. From an early age, his ambition was to become a pilot, so he took on casual jobs to raise money for flying lessons. Givens would hitchhike out to the Childress Municipal Airport, where instructor "Red" Emerson from the Ragsdale Flying Service guided him towards gaining his student pilot's license in 1946. The day after he turned sixteen, he made his first solo flight.

After graduating from high school, Givens spent a semester at Texas A&M University and three semesters at the University of Oklahoma, before receiving an appointment to the U.S. Naval Academy in Maryland as a member of the Class of 1952. He not only impressed his math professors with his proficiency in the subject, he also won acclaim as an adept midfielder at varsity lacrosse. He would be awarded his bachelor of science degree in Naval Sciences.

Tragedy would strike the Givens family around this time, when his younger brother and only sibling, Donald, a navy aviator, was killed along with nine other cadets, enlisted men and officers in an airplane crash while based at NAS Corpus Christi, Texas.

After graduating from the Naval Academy in 1952, Givens chose to enter the U.S. Air Force and received flight instruction at Goodfellow AFB in San Angelo, Texas. His first flight with the Air Force took place on August 18, 1952, in a North American T-6 *Texan* training airplane. He completed his training at San Angelo on February 4, 1953, received his commission as a 2nd Lt. in the Air Force, and was awarded his pilot's wings. As one of the top-ranked students, he was allowed the privilege of deciding which branch of the Air Force he wished to join, and opted for fighter training. He subsequently received advanced training at Williams AFB in Phoenix, Arizona, and Perrin AFB in Sherman, Texas. In 1954, newly promoted to 1st Lt., he was assigned to the 35th Fighter Interceptor Group, then on duty in Japan. As a fighter pilot and flight commander, he began to relish the prospect of becoming a test pilot back in the United States.

Returning home, Givens received an assignment in January 1956 as an instructor at the Air Force Interceptor Weapons School in Panama City, Florida, where he remained until March 1958. He subsequently attended the USAF Experimental Test Pilot School (ETPS) at Edwards AFB in California with the rank of captain. On graduation, he received the A.B. Honts award as the outstanding student of Class 58B. He also received the UK's Empire Test Pilots' School Award for academic achievement – one of the few graduates ever to receive both awards. He then became an instructor at Edwards' Stability and Control section. It was during this time that he received the call to attend a briefing in Washington, D.C., for possible astronaut selection, and although he made it to the final 32, he progressed no further this time around.

Following his unsuccessful bid to become a Mercury astronaut, Givens returned to his instructing duties at Edwards. Later, in company with civilian instructor colleague William Schweikhard, he proposed the concept of a full aerospace course to the new commandant of the ETPS, Maj. Richard C. Lathrop. As the Air Force was slowly moving towards manned spaceflight operations, Lathrop saw great merit in their proposal and asked his special assistant, Maj. Thomas McElmurry, to help the men to get the project up and running. When future astronaut Capt. Frank Borman joined Group 60C early in 1961, he also became a staunch advocate of the aerospace course and assisted the others as they presented their concept to the Air Force higher echelons, steadily gaining sufficient support for developing the advanced course. On 5 June 1961, the Aerospace Research Pilot School (ARPS) finally became a reality at Edwards, with an initial class of student aerospace pilots.

Unlike his colleagues, however, Givens was not included in this initial aerospace course, having returned to the Navy on a two-year posting as an exchange project pilot with Air Development Squadron 4, based at NAS Point Mugu, northwest of Los Angeles. Here, he was responsible for conducting and developing procedures and tactics for fleet operations of the F8U-2N *Crusader*.

Givens returned to Edwards in November 1961 with duties in Stability and Control, and was then assigned as special assistant to the new Commandant of the ARPS, Lt. Colonel Robert Howe, pending a permanent assignment within the staff. Meanwhile, he became a member of the third ARPS group, Class III. Other future NASA astronauts on this 7-month course were Charlie Bassett, Michael Collins and Joe Engle. On New Year's Eve, he attended a party where he met his future bride, German-born Ada Eva Muuss.

Ed Givens, USAF, being dressed in a Gemini pressure garment for tests wearing the AMU.

Following his graduation from the ARPS, Givens became a qualified USAF astronaut-designee, which meant he was now eligible for any of the Air Force's proposed manned space programs, or as a NASA astronaut. He was certainly interested in the X-20 Dyna Soar program but when that was cancelled in December 1963, he began work on the Air Force's Manned Orbiting Laboratory (MOL). He was assigned to the Air Force Systems Division Office, Detachment 2, as a project officer at the Manned Spacecraft Center (MSC) in Houston, where he was involved in designing the Astronaut Maneuvering Unit (AMU), which was to have been used by spacewalking MOL astronauts.

In September 1965, NASA began a recruiting drive for a new intake of astronauts and Givens applied. As in 1959, he had to endure several probing interviews and a thorough physical checkout at the School of Aviation Medicine at Brooks AFB in San Antonio, Texas, but this time Givens, along with eighteen other candidates, was subsequently ordered to report to Houston for astronaut training by May 1. [16]

FRED W. HAISE, JR.

Over four harrowing, tension-filled days in April 1970, people around the world held their collective breath as Apollo 13 astronauts Jim Lovell, Fred Haise and Jack Swigert fought a desperate struggle for survival in space. Just 55 hours after they were launched to the

Moon, an explosion in the cryogenic oxygen system blew the side out of their Service Module, forcing NASA to abort the Moon landing and work frantically on unprecedented ways of getting the crew safely back to Earth. Meanwhile the three astronauts, stranded without electrical power, computers or the use of their propulsion system, were forced to evacuate into Lunar Module Aquarius*, using it as an unintended lifeboat while trying to find some way to purge their cramped living space of a potentially lethal build-up of carbon dioxide. Though the catastrophic explosion prevented the Apollo 13 mission from successfully achieving its objective, the ensuing survival story has become a classic of American history. Haise was later to play another key role, in the development of the Space Shuttle landing techniques as the Commander of the first Approach and Landing Test crew. Although chosen to command an early Shuttle mission, he decided to step down and take an aerospace management role instead.*

On November 14, 1933, Fred Wallace Haise and his wife, the former Lucille Blacksher, celebrated the birth of their first child – a son – who would be named after his father. They lived in a house on Church Street (since 1970, renamed Haise Street) in Biloxi, Mississippi, where Fred Jr. grew up along with his two younger sisters, Brenda and Eydie.

While attending grade school, Haise picked up his lifelong nickname of "Pecky," when he played the role of a woodpecker in a school play. His education later continued at Biloxi High School. As a youth, Haise admits he had no real interest in airplanes or wanting to fly, instead looking forward to one day becoming a news reporter. In school, he showed more interest in journalism than anything else, and became sports editor of his high school newspaper. He was also a Boy Scout, eventually earning the rank of Star Scout. "As a boy, I was in the Pine Burr Council Troop 212, Dan Beard Patrol in Biloxi," he recalled. "My scoutmaster was E.P. Wilkes, the original founder of the Biloxi/Gulfport *Daily Herald*." [17]

His first job was delivering the *Daily Herald* on his bicycle and he then took on part-time work as a cub reporter at the newspaper itself, at that time the second-largest daily paper in Mississippi. He even worked there during his two summer breaks. In 1970, the newspaper's editor, Cosman Fisendrath, laughingly revealed that "Freddy worked for me about two years as a part-time reporter. He made 75 cents an hour." [18] According to a 1950 graduation prophecy in the Biloxi High School annual, 16-year-old Haise was said to be destined one day to become editor of the *Chicago Tribune*. It was during his high school days that Haise, then 15, began dating Mary Grant, a pretty girl one year his junior. They married six years later.

While attending Perkinston Junior College (now Gulf Coast Community College) in Mississippi, Haise became even more determined to become a reporter, writing for the school paper and majoring in journalism through his first two years of college. Graduating with his Associate of Arts degree in 1952 at the age of 18, he realized that he was now eligible for the military draft. Rather than risk being drafted during the Korean War, but wanting to serve his country, he enlisted in the Naval Air Cadet program, in order to continue his studies and become a pilot before resuming his ambition to go into journalism.

It was a career move that would dramatically change the course of his life. He said that he joined the cadet scheme because it was the only program he could get into at the age of 18, with two years of college. "Like most kids at that age, you kind of jump into things before you really think about it. It began to worry me, near the end of three or four months of pre-flight training, when all at once I realized that I was actually going to have to fly an airplane as part of that goal of getting a commission. I'd never flown before in my life.

I'd had no inclination toward flying prior to that time." Haise completed his pilot training at NAS Pensacola, Florida, and, to his surprise, discovered that not only he was a natural pilot, but that flying gave him "a lot of enjoyment and self-satisfaction" [19]. After receiving his wings, he took his commission in the Marine Corps instead of the Navy and then served as a tactics and all-weather flight instructor in the Navy's Advanced Training Command at NAS Kingsville, Texas.

In March 1954, he was assigned to VMF-533 and spent the next two years as a Marine Corps fighter pilot at Cherry Point, North Carolina. Later assigned to VMF-114, he remained at Cherry Point until September 1956, when he took his discharge. By this time, Haise was thoroughly hooked on aviation and decided to return to school in order to earn a degree in aeronautical engineering. With this in mind, he entered the University of Oklahoma and joined the Oklahoma Air National Guard so he could fly on weekends.

In 1959, Haise received his bachelor of science degree in Aeronautical Engineering, with honors, and immediately after graduating accepted a job as a research pilot at NASA's Lewis (now Glenn) Research Center in Cleveland, Ohio. Having moved to Cleveland to work, he transferred to the Ohio Air National Guard. When the Berlin crisis arose in 1961, his national guard unit was activated and Haise spent 10 months in the Air Force as a tactical fighter pilot and chief of the 164th Standardization-Evaluation Flight of the 164th Tactical Fighter Squadron, based at Mansfield, Ohio.

In March 1963, following his second discharge from military service, NASA transferred Haise to Edwards AFB, California, where he became a research pilot with the NASA Flight Research Center. The following year, he was chosen to attend the prestigious ARPS at Edwards. He would graduate as the outstanding student of Class 64A, remaining at Edwards over the next two years. His next assignment came in April 1966, when he was selected into NASA's astronaut corps.

JAMES B. IRWIN

Growing up with a fascination for aviation, even the young Jim Irwin could never know that one day he would become the eighth person to walk on the Moon. In the summer of 1971, he spent three days exploring the surface of the Moon with his commander, Dave Scott, as LMP for Apollo 15, while his Group 5 colleague Al Worden orbited overhead in the Command and Service Module. This mission was the first of the three 'super-science' Apollo lunar missions, with extended lunar stay time capabilities, expanded scientific packages to study the Moon from orbit as well as the surface, and the first use of the Lunar Roving Vehicle which greatly expanded the exploration capabilities of the astronauts. In an ironic twist of fate, Irwin died on August 8, 1991, just a day after the 20th anniversary of his return from the flight of Apollo 15.

James Benson Irwin was born in Pittsburgh, Pennsylvania, on March 17, 1930, to James Irwin and the former Elsie Strebel. The fact that he was born on St. Patrick's Day delighted his Irish-born father, a World War I infantryman who came from Pomeroy in County Tyrone, now part of Northern Ireland. A plumber by trade, his father worked as a steamfitter at the Carnegie Museums of Pittsburgh, running the huge turbines that generated power for the immense building. Young Jim's interest in flying began while he was in second grade, when a neighbor gave him a superb model aircraft, which he treasured. His interest intensified when his father took him on outings to a nearby county airfield to watch airplanes take off and land.

When he was 11 years old, Irwin's family moved to New Port Richey and then Orlando, Florida. Later moves took the family to Roseburg, Oregon and Salt Lake City, Utah, where he graduated from East High School in 1947. He then won an appointment to the U.S. Naval Academy, graduating four years later, on June 1, 1951, with his bachelor's degree in Naval Science. Irwin then jumped at his chance to join the U.S. Air Force, was commissioned a 2nd Lt., and took his flight training in T-6 *Texan* propeller aircraft at Hondo AFB and later Reece AFB, both in Texas. He was then assigned to a squadron based in Yuma, Arizona as a P-51 *Mustang* pilot, later transitioning to the T-33 *Shooting Star* jet fighter. He would then complete graduate school at the University of Michigan, graduating with master of science degrees in both Aeronautical Engineering and Instrumentation Engineering. Irwin then served the next three years as a project officer in the AIM-47 *Falcon* air-to-air missile program at Wright-Patterson AFB, Ohio.

In 1961, Capt. Irwin was assigned to the USAF Test Pilot School, Class 60C, at Edwards AFB, California. Following the class graduation in April 1961, he stayed on at Edwards as a test director in the armament section. Soon after, he was told that he was in line to become the first test pilot on a new, top-secret Mach 3 Lockheed airplane called the YF-12A "which we called the A-11" (a precursor to the SR-71 *Blackbird*). There was an interim period between his TPS graduation and taking up this new and exciting role, and he decided to get in some additional flying in light airplanes and also to qualify for his instructor's license. His pupil one weekend was M. Sgt. Sam Wyman, who had undergone some flight training during World War II but had never flown solo. However, as Irwin recalled in his 1973 memoirs (*To Rule the Night*), his student was "nervous and tended to overreact."

As the time approached for Wyman to attempt his first solo landing, he became increasingly worse in his technique, and his landings were not good enough to permit him to fly by himself. One Sunday, seated in the front seat, his first attempt at landing was poor, landing tail wheel first and bouncing. On the fourth or fifth attempt at landing, disaster struck. "I was in the back seat," Irwin recalled. "He pulled the plane up too abruptly, turned it too tightly onto the crosswind, and we went into an uncontrollable flat spin." [20]

The light aircraft crashed into the desert and Wyman's head smashed into the front panel. Irwin hit the back of the front seat with his head turned sideways. "I was wearing tennis shoes, and when we hit, the front seat collapsed on my feet, particularly my right foot. The seat came down right above my ankle, giving me a compound fracture, with the bones sticking out through the flesh. I had two broken legs, a broken jaw, and a head injury. I was pinned in the wreckage. Fortunately, the plane did not catch on fire."

Sam Wyman was critically injured, but would survive. Irwin came perilously close to having his leg amputated, but after fourteen months of physiotherapy he was once again permitted to go back to flying status. In the meantime, he had to relinquish his role as the first test pilot of the YF-12A. Soon after, he gained admittance to the ARPS, graduated, and applied to NASA for the third group of astronauts, but missed the final selection cut. "They didn't tell you why," he reported, "but I am sure it was because of that recent accident on my record."

Three years later, at the time of his selection into NASA's Group 5 astronauts, Irwin was serving as the chief of the Advanced Requirements Branch at Headquarters, Air Defense Command, in Colorado Springs.

DON L. LIND

According to the authoritative online Astronautica Encyclopedia*, the longest any person has had to wait for their first flight after selection to their nation's space program was Ukrainian test pilot Leonid Kadenyuk, who achieved his first space flight 21 years and three months after being selected as a cosmonaut candidate. Not too far behind him in the waiting stakes was Don (not Donald) Leslie Lind, who was announced as a Group 5 NASA astronaut on April 4, 1966, and flew his maiden journey into space on April 29, 1985 – just over 19 years later. Had budget cuts not caused the cancellation of the last three planned Apollo lunar landing missions and curtailed an extensive proposed, but unfunded, follow-up program, he may very well have landed on the Moon as a Lunar Module Pilot on Apollo 21.* [21]. *As well as missing out on an Apollo mission, Lind also trained for a rescue mission, along with Vance Brand, after the second Skylab mission (SL-3) appeared to be in trouble. Two steering control rockets on the Apollo spacecraft's Service Module were plagued by propellant leaks, reducing the craft's attitude control system to what was described at the time as a minimum flyable condition. However, this problem was rectified in time and the two-man rescue mission subsequently abandoned. "I set a record," Lind told interviewer Rebecca Wright in 2005. "No [U.S. astronaut] has waited for a space flight longer than I have. I hope nobody ever has to do that. But with the six and a half years I spent in training for the two flights that didn't fly, and then the delays in getting the Shuttle [program going], and with the [Apollo] fire, there were long delays, and so, yes, it was nineteen years before I got to fly."* [22]

Born on May 18, 1930, to Leslie and Elizabeth Lind in Midvale, in Salt Lake County, Utah, young Don was a sickly child who was prone to catching numerous diseases and colds with ease, requiring special attention from his anxious but caring parents. Things were so serious that, when he was just three months old, a specialist told them that if he could make it to five years old he would probably live and become a healthy person. "Until I was about two," he mentioned in his biography, "I spent most of my playtime on top of the kitchen table so I wouldn't be in drafts near the door." [23]

While his school teacher mother would read to him, he first gained an appreciation for physics through his father, an electrician, who would take time to explain the way things worked, with astronomy being of particular interest. "Under his tutelage, I learned about the phases of the Moon, levers and wedges, inclined planes, and other fascinating principles of physics. I could do problems in long division before I entered first grade, because my parents took time to explain things to me." [23] He also found great excitement in the fictional comic book adventures of space heroes Buck Rogers, Flash Gordon, and Brick Bradford.

By the time Lind entered grade school, his health had greatly improved and as he grew stronger, he was finally able to play outside and enjoy a normal boyhood. Together with his two younger sisters and a cousin, he would often climb trees. Climbing one such tree in a meadow near the family home, he would shake the branches to simulate a rocket ship hurtling through space. After attending Midvale Elementary School and Jordan High school in nearby Sandy, Lind studied physics for two years at the University of Utah. He served at a mission for the Latter Day Saints Church in the northeastern states and, on his return, completed his bachelor's degree in Physics in one year, graduating from the university in 1953. The following year, he enlisted in the U.S. Navy, entering the Navy's Officer Candidate School at Newport, Rhode Island, hoping one day to be among the fastest and most daring of aircraft carrier pilots; a goal he later attained. Eventually, he was commissioned an ensign in the Naval Reserve. As he waited for his orders to ship out, Lind enrolled for a quarter at Brigham Young University, a private university affiliated with the Mormon Church. While there, he met Kathleen Maughan. They were married on April 1, 1955 while he was on leave from the Navy.

Beginning in 1954, Lind served on active duty with the Navy, first based in San Diego and later as a carrier pilot aboard the *USS Hancock* (CV-19). Leaving active service in 1957, Lind remained in the Naval Reserve, in which he would eventually reach the rank of commander (1969), before retiring from the service. As a Navy aviator during the Korean War, Lind contacted scientists at the University of California and volunteered to take up photo emulsions to record cosmic rays, flying as high as 50,000 feet (15,240 m). That research opened the door to University of California, Berkeley, where he was awarded his doctorate degree in High-Energy Nuclear Physics in 1964 while working at the Lawrence Radiation Laboratory. Until his selection for the astronaut program, he worked as a space physicist at NASA's Goddard Space Flight Center in Greenbelt, Maryland, where he was involved in experiments to determine the nature and properties of low-energy particles within Earth's magnetosphere and interplanetary space. [**15**]

JACK R. LOUSMA

Colonel Jack Robert Lousma would enjoy a stellar career with NASA, initially as a support crew member for Apollo 9, 10 and 13. He was the Capcom on duty when the explosion within the Service Module of Apollo 13 not only threatened to terminate the lunar landing mission, but placed the three astronauts in immediate peril. It is thought that Lousma lost the opportunity to fly to the Moon as LM Pilot when Apollo 20 was cancelled in 1970. Transferring to the Skylab program, he served as the pilot on the record breaking 59-day third manned mission, Skylab 3, in 1973 and, after serving as back-up Docking Module Pilot for ASTP in 1975, Lousma commanded the third Space Shuttle mission, STS-3, in 1982.

When Marine fighter and reconnaissance pilot Jack Lousma indicated to his wife Gratia in 1966 that he was thinking of applying for NASA's fifth intake of astronauts, he felt he stood little chance among the thousands of other qualified applicants he would be up against in the selection process. "But I knew I would kick myself if I didn't at least try," he stated. He was a little taken back when Gratia quickly, and even eagerly, agreed that he should give it a shot. "I found out only recently that she told me to go ahead without any hesitation because she really didn't think it would happen. I guess I surprised us both." [**24**]

A leap year baby and a deeply religious man, Lousma was born in Grand Rapids, Michigan, on February 29, 1936. He took his early education at Tappan Junior High School and Ann Arbor High School, where he became captain of the football team. He also began dating class homecoming queen Gratia Kay Smeltzer, whom he eventually married in 1956. They both graduated in 1954, following which Lousma attended the University of Michigan, eventually deciding to switch from business studies and receiving his bachelor of science degree in Aeronautical Engineering in June 1959. After receiving his degree, Lousma enrolled in the Marine Corps Officer Candidates School in Quantico, Virginia. Following the completion of his flight training at the Naval Air Training Command, he received his aviator wings in 1960. He was then assigned to VMA-224, 2nd Marine Air Wing (MAW), as an attack pilot, and later served with VMA-224, 1st MAW, at MCAS Iwakuni, Japan. He later flew as a reconnaissance pilot with VMCJ-2, 2nd MAW, based at MCAS Cherry Point, North Carolina. In 1965, he was awarded his master of science degree in Aeronautical Engineering from the U. S. Naval Postgraduate School in Monterey, California, before he successfully applied to become a NASA astronaut, although he would always maintain he was a marine first and an astronaut second.

"Aviation kind of runs in the family," he told a NASA interviewer when asked how he first became interested in flying. "When I was a kid, I always enjoyed airplanes. I'd make model airplanes and so forth. I remember being at my grandfather and grandmother's farm in Michigan, just four or five years old, and I had a cousin who was in the Army Air Corps and he flew fighters. I don't know how he got to do it, but he flew them wherever he wanted to, I guess. But I remember they said, 'Your cousin Gordon is going to fly over the farm in a little while,' and sure enough he did. He just came so low between the barn and the windmill … and I could almost see his eyeballs. I said, 'Wow!' And perhaps that had something to do with it … I was always interested in airplanes as a youngster, but I'd never really flown. My father took me to the airport around Ann Arbor frequently, just a grass strip out in the country, and we'd watch airplanes land and take off, just fun to do." [25]

THOMAS K. MATTINGLY II

Naval Aviator Ken Mattingly served on several support crews and would have flown on the ill-fated Apollo 13 mission, had he not attended a family party a couple of weeks prior to the mission. It later transpired that one of the children at that party had come down with German Measles, to which Mattingly had never been exposed. Fearing the possibility that he may become ill during the mission, he was replaced by his back-up and fellow Group 5 astronaut Jack Swigert 72 hours prior to launch. The rest, as they say, is history. Mattingly, who never did come down with the illness, supported the herculean effort on the ground to save and recover the crew following the onboard explosion on the way to the Moon. Reassigned to a new crew, he completed his first spaceflight as Command Module Pilot of Apollo 16, before transferring to the Shuttle Branch Office, flying as commander of the fourth and final orbital test flight in 1982 and the first classified military Shuttle mission in 1985.

Thomas Kenneth Mattingly II was born in Chicago, Illinois on March 17, 1936. Soon after he was born, his father took up a position with Eastern Airlines, which resulted in the family moving to Hialeah, Florida, a city rich in aviation history.

When asked in 2001 how he first came to be interested in flying, Mattingly responded, "I think it's in the genes. As a kid, my earliest memories … all had to do with airplanes. My dad worked for Eastern Airlines. Before I had any idea what that was, my toys were all some kind of airplane, and any picture that you could glean from when I was a child, they always had an airplane in it … It was just a way of life." [26]

He also revealed that, while attending elementary school in Hialeah, he began reading books on space-related subjects when he was 10 years old. One of the first books he recalled owning on the Moon was titled "*The Earth's Nearest Neighbor*" (Bertha Morris Parker, published by Peterson & Co. in 1941). Through his father's work, Mattingly was able to take a number of fascinating airplane rides to the end of different airline destinations and back.

At the age of 11, sixth-grade student Mattingly opened his own hobby shop in the family garage, where he would design and build model aircraft while his father carefully explained the principles of flight to the eager boy. A youthful entrepreneur, he sold many of his model airplanes in order to build even more sophisticated models. In fact, one of his models was so well constructed that it won a world speed record, attracting a flow of business the way of his father's garage. When a local hobby store closed, he even arranged to buy part of the stock. Business was so good, he decided to go to city hall and apply for a retailer's license. "They wouldn't sell it to me, just because I was a minor," he said of his youthful enterprise, "and they told me I couldn't advertise, post a sign or keep a very big stock." Nevertheless, he stayed in business until other concerned hobby dealers submitted a petition stating that the boy was not licensed to sell, and his first business venture was subsequently closed down. [27]

In school, Mattingly achieved consistently high grades and became interested in music and student politics. In junior high school, he was elected student government president and when he attended Miami Edison Senior High School, he took up the drums. However, aviation remained a key interest, and he was once asked to leave an orchestra rehearsal after flying a model airplane over the heads of the musicians. He was also active in the Boy Scouts and would achieve the movement's second-highest ranking of Life Scout.

On graduating from Miami Edison on June 4, 1954, Mattingly was ranked 46th in his high school graduation class of 751. He decided to pass up a scholarship in music to accept an officer-training scholarship from the Navy and was enrolled at Auburn University in Alabama. Here, he would train in the Navy's ROTC program, at first studying engineering physics before dropping the subject and taking on another course in aeronautical engineering, which he found far more to his liking. At Auburn, he became a member of the Delta Tau Delta fraternity (Epsilon Alpha chapter), frequently made the dean's honor list, and was elected student body president. After graduating with his bachelor's degree in Aeronautical Engineering in August 1958, Mattingly was commissioned an ensign in the U.S. Navy. But then he struck a major hurdle in his cherished ambition to one day become a test pilot.

"When I graduated from college and got my commission, I volunteered for flight training and wasn't selected. I was crushed. Other people in my class had grades that weren't as good, were not engineers – and I could never figure it out. I ended up being sent to a pre-commissioning detail on a ship called the *USS Galveston* [CL-93]. It was in dry dock in Philadelphia. So here I was, a brand new ensign, wanted to be in flight training, and instead I was up in this shipyard, [on] a ship that didn't even go to sea. You walked across a gangplank, but there was no water underneath you; it was just concrete." [28]

He was both dejected and puzzled at this turn of events, but eventually decided to call the Navy Bureau of Personnel in Washington to ask why he had missed out on flight training. To his surprise, he was told that he had excellent grades and other skills and they had been wondering why he had never applied for aviator training. The reason, it turned out, was that he had not completed an application form in order to qualify – a simple but vital mistake. This was quickly remedied, and two years later he completed his flight training and was awarded his Wings of Gold as a naval aviator. He was then assigned to Attack Squadron 35 (VA-35), based at NAS Jacksonville, Florida, initially flying Douglas A-1H *Skyraider* aircraft from the aircraft carrier *USS Saratoga* (CV-60).

One momentous day, a friend from a photo reconnaissance squadron asked Mattingly if he would like to accompany him in another aircraft on a flight to Cape Canaveral, where he had been assigned to take photos of the first manned Gemini launch, GT-3. Mattingly was interested, but flights into space back then were only of passing interest to him. "I had not been impressed with the space program at that point," he said in a NASA interview in 2001. "I thought the pictures in the magazines of Mercury and Gemini weren't visually appealing. Airplanes are supposed to be smooth, and there's an elegance to them … I can't imagine how anybody could be interested in that. It just had no appeal." [28] As he circled the Cape at lift-off, he observed the launch of the Titan rocket carrying Gus Grissom and his future Apollo 16 crewmate John Young, and as he watched and listened to the voice transmissions from the spacecraft, he came to realize that it was a truly exciting thing after all.

By this time, he was flying with Heavy Attack Squadron 11 (VAH-11), deployed aboard the carrier *USS Franklin D. Roosevelt* (CV-42) and flying Douglas A-3B *Skywarrior* swept-wing jet aircraft, but after completing five years of sea duty, his ambition was to gain an assignment to the test pilot school at Patuxent River, Maryland. However, the Navy wanted him first to obtain a master's degree in Aeronautical Engineering from postgraduate school, and he decided he would rather attend Harvard, which meant resigning from the Navy. But fate stepped in before he resigned from the service, when he received a phone call asking if he would consider transferring to the U.S. Air Force TPS at Edwards AFB in California, even though he was still a naval aviator. It was the opportunity he had been seeking, and he accepted. After graduating from test pilot school, Mattingly stayed on at Edwards, flying far more advanced aircraft as a student at the ARPS. During this time, he and fellow Navy student pilot Ed Mitchell heard that NASA was looking for further astronauts, while at the same time, the Air Force was also seeking astronauts for its MOL program. Both of them decided to apply for selection to MOL, but missed out. Then fortune smiled on them again, when they were asked if they wanted to transfer their applications to NASA. This time both men were successful. A month before they graduated from the ARPS, Mitchell and Mattingly were named as NASA astronauts.

BRUCE MCCANDLESS II

In the first six decades of human space travel, literally hundreds of thousands of mission photographs have been taken. Many of them are unforgettable testaments to particular events in that amazing period of discovery and enterprise. The standout image of the Gemini program is undoubtedly that of tethered astronaut Ed White, conducting America's first spacewalk, or Extra-Vehicular Activity (EVA) in the NASA lexicon. The world marveled at the incredible photograph of the Earth rising above the surface of the Moon, snapped by the crew of Apollo 8. Perhaps the most memorable photograph of the entire space era to date would have to be that of Buzz Aldrin standing on the surface of the Moon, with Neil Armstrong reflected in Aldrin's gold visor. In NASA's Space Shuttle era, there is one photograph above all others that has graced the covers of countless books and magazines. It is a 1984 photo of a lone astronaut, on mission STS-41B, flying completely free of Space Shuttle Challenger *while strapped into a $10 million device called the Manned Maneuvering Unit (MMU). That astronaut, who became the first human satellite, was U.S. Navy Captain Bruce McCandless II, who had been on duty as EVA Capcom for the historic first Moonwalk in 1969. In 1990, he was back in space as a member of the Shuttle crew which deployed the highly successful Hubble Space Telescope.*

A total solar eclipse occurs when the Moon passes between the Earth and the Sun, blocking all sunlight and turning day into night. It is a rare event, but one such total eclipse took place on June 8, 1937. On that same day, a family in Boston, Massachusetts, celebrated their own stellar event with the birth of a baby son. His father Bruce McCandless – a later recipient of the Congressional Medal of Honor – had followed a family tradition by serving in the U.S. Navy. He would eventually rise to the rank of rear admiral before retiring in 1952. The happy new mother was the former Sue Worthington Bradley, also the daughter of an officer in the U.S. Navy. They would name their son Bruce McCandless II.

The family has an interesting background. The senior Bruce McCandless was the great-grandson of David Colbert McCanles, one of several men killed in a fierce, bloody shoot-out in Nebraska with Wild Bill Hickok in 1861. After that incident, the McCanles family changed its name to McCandless and moved to Florence, Colorado. [**29**]

Bruce and Sue McCandless would eventually have four children; two sons (including Bruce II) and two daughters. The younger Bruce attended Woodrow Wilson Senior High School in Long Beach, California until 1954. He was then accepted into the U.S. Naval Academy in Annapolis, Maryland, graduating second in a class of 899 midshipmen on June 4, 1958 with his bachelor of science degree in Naval Sciences. Following his graduation, McCandless undertook training as a pilot at the Naval Aviation Training Command based in Pensacola, Florida, and then at Kingsville, Texas. He received his aviator wings in March 1960 and proceeded to NAS Key West, Florida, where he underwent weapons systems training and aircraft carrier landing instruction, flying the Douglas F-6A *Skyray* aircraft.

USNA Class of '58 graduates Bruce McCandless II (right) and Alan Chodorow (left) toast John M. Poindexter on achieving the rank of honor man. (Image courtesy Associated Press).

On August 6, 1960, McCandless married Alfreda Bernice Doyle. They would have two children. In December 1960, McCandless was assigned to the 102nd Fighter Squadron (VF-102), flying the *Skyray* and F-4B *Phantom II* aircraft from the *USS Forrestal* (CVA-59) and the *USS Enterprise* (CVA-65) aircraft carriers. The latter ship participated in the October 1962 naval blockade of Cuba while McCandless was serving aboard. In early 1964, he served for three months as an instrument flight instructor in the 43rd Attack Squadron (VA-43), based at Apollo Soucek Field at NAS Oceana, Virginia. He then continued his education at Stanford University in Stanford, California, through the Naval Reserve Officer's Training Corps Unit (NROTC). There, on June 13,1965, he was awarded his master of science degree in Electrical Engineering [13]. In his time as a Navy aviator, McCandless gained proficiency on almost a dozen aircraft, including jets and helicopters.

EDGAR D. MITCHELL

After his death in February 2016, several obituaries published on NASA astronaut and Moonwalker, Ed Mitchell, erroneously reported that he was born in Roswell, New Mexico, although that is where he did take his early education. If there is irony to be found in his story, it is the fact that he died just seven hours before the 45th anniversary of that historic moment — on February 5, 1971 — when he landed with Alan Shepard in Apollo 14's Lunar Module, Antares, *in the Fra Mauro crater. To the chagrin of many people who knew and worked with him, Mitchell will always be remembered as the astronaut who believed that the alleged 1947 crash of an alien spacecraft in Roswell actually happened, and that governments worldwide have hidden the truth for more than six decades. It is an unfortunate but undeniable fact that the name of the man who became the sixth person in history* *to walk on the surface of the Moon will forever be cited for his firm belief and outspoken views that aliens have frequently visited our planet. As he stated during a radio interview in 2008, "I happen to have been privileged enough to be in on the fact that we've been visited on this planet, and the UFO phenomenon is real."* [30]

Edgar Dean Mitchell was born on September 17, 1930, in the small farming town of Hereford, in the Texas panhandle. He grew up as the first of three children born to Joseph Thomas Mitchell (known as JT), a third-generation cattle rancher, and the former Ollidean Arnold. His family, Texas ranchers since the Civil War, would lose everything in the drought and depression of the 1930s. "My grandfather, father and uncle were driving stakes for the Santa Fe Railroad for a dollar a day," Mitchell once recalled. [31]

As a youngster, Ed Mitchell first became enthralled by airplanes while watching crop duster pilots flying biplanes out of an airfield near his home. He made his first flight in a Curtiss JN-4 "*Jenny*" airplane at the age of four when a barnstorming pilot landed in a field and asked his parents for some gasoline. In 1935, when he was five years old, Mitchell's family, including sister Saudra Jo and his then only brother Jay, moved to Roswell, where he took his early education through to the seventh grade, at what is now called Berrendo Elementary School in Roswell. Amazingly enough, in the context of his later life, he used to walk past the home of rocket pioneer Robert Goddard every day on his way to school. Every so often, he would see Goddard launching one of his tiny rockets into the sky. "He was 'Crazy Goddard' to the local folks," Mitchell once mused. "I was afraid to go over there, but I was intrigued by the whole thing." [31]

His family then moved once again, to 609 Dallas Avenue, Artesia, some 40 miles north, where his father and grandfather had established a cattle ranch and farm implement sales business. Thereafter, Mitchell would always consider Artesia to be his hometown.

By the time he was 13, Mitchell was washing aircraft at Artesia municipal airport, in return for a 30-minute flying lesson. In 1944, at the age of 14, he first flew solo in a Piper J-3 *Cub* propeller-driven aircraft. The future astronaut shared a love of flying with his lifelong friend Tom Brown. Once they reached the necessary age, they would climb aboard his friend's motor scooter and head for the airport to train as flight students. He earned his pilot's license in 1946, aged 16. "I still laugh that we both started flying at the same time," Brown once said in recalling his boyhood buddy. "I tell people there wasn't a heck of a lot of difference – I got a private pilot's license, and he walked on the Moon!" [32]

Mitchell graduated from Artesia High School on May 21, 1948, and then took on further studies at the Carnegie Institute of Technology (now Carnegie-Mellon University) in Pittsburgh, Pennsylvania, on the subject of industrial management. He worked his way through the institute by chipping slag out of the bottom of blast furnaces. On his first day at Carnegie, he met an art student named Louise Randall, whom he would marry on December 21, 1951.

After graduating with his bachelor's degree in Industrial Management on June 7, 1952, Mitchell enlisted in the U.S. Navy and completed his basic training at the Fleet Training Center in San Diego, California. In May the following year, having completed Officer Candidate School in Newport, Rhode Island, he received his commission as a Navy ensign and pilot. [13] He then completed his flight training at Hutchinson, Kansas in July 1954, and was shipped out to Okinawa in the waning days of the Korean War, where he flew the Douglas A-3 *Skywarrior* from aircraft carriers with Patrol Squadron 29, even being shot at on one occasion.

In 1957, Mitchell was assigned to Heavy Attack Squadron 2 aboard the carriers *USS Bon Homme Richard* (CV-31) and *USS Ticonderoga* (CV-14). It was while standing on the deck of the latter ship one night in the Pacific in late 1957, on his way back home to do some work as a test-pilot, that the 27-year-old Mitchell looked up into the heavens and watched in wonder as a small, shining dot traversed the night sky. It was the carrier rocket that had carried the first Sputnik into orbit (the beach ball-sized satellite itself was too small to be seen) and it had a powerful influence on him. "When Sputnik went up," he later recalled for NASA's Oral History program, "I realized humans were going to be right behind it, so I started orienting my career toward that at that time." [33]

He then started to seek opportunities to become involved in this exciting new development. Upon his return to the United States, Mitchell furthered his education, earning a bachelor of science degree in Aeronautical Engineering from the U.S. Naval Postgraduate School in 1961. He then served for a year as a project research pilot with Air Development Squadron 5, and received his doctorate of science in Aeronautics and Astronautics from the Massachusetts Institute of Technology (MIT) in 1964. Afterwards, he became chief of the Project Management Division of the Navy's field office for the military's MOL program.

Beginning in 1965, he completed test pilot training at the ARPS at Edwards AFB, California, in preparation for astronaut duties and certification as a test pilot. After graduating first in his class, he served as an instructor at Edwards in advanced mathematics and navigation theory for astronaut candidates.

WILLIAM R. POGUE

Ex-Thunderbirds aerial display pilot, Bill Pogue, flew as a crewmember for one of the most important missions in early spaceflight history. As Pilot of Skylab 4, Pogue set the record for space endurance of 84 days, together with Commander and fellow Group 5 astronaut Jerry Carr and Group 4 scientist astronaut and mission Science Pilot Dr. Ed Gibson. Their record was not surpassed until 1978 by the Soviet Union and 1995 by another American astronaut. After serving on a number of Apollo support crews, Pogue was in line to fly as Command Module Pilot for Apollo 19 with fellow Group 5 astronauts Fred Haise (Commander) and Jerry Carr (LM Pilot). Then, in September 1970, the mission was cancelled, partly as a result of cuts in the NASA budget, and Pogue was transferred to the Skylab program which gave him his only spaceflight. Had Haise, Carr and Pogue flown on Apollo 19, they would have become the first (and probably only) prime crew comprised solely of members from the fifth astronaut group.

Okemah is a small city of just 2.7 square miles, located in the county seat of Okfuskee County, central Oklahoma. In 1930, the population was hovering just below 4,000 inhabitants, and while one of its most famous sons, 18-year-old folk hero Woodie Guthrie, had relocated to Texas the previous year, it gained another in the form of future NASA astronaut Bill Pogue.

William Reid Pogue was born on January 23, 1930, a second child for Alex Wallis and Margaret Frances (née McDow) Pogue, and a brother to Margaret Helen Pogue. He would later tell interviewers that he had ancestors who were members of the Choctaw nation.

Pogue took his early education at Lake Elementary School, where his father was a teacher and school principal, later graduating on May 22, 1947 from Sand Springs High School (now Charles Page High School). Like so many other young boys, he was fascinated by airplanes, but his plans for the future were directed more towards becoming an educator like his father, specializing in mathematics or physics. He then attended Oklahoma Baptist University, where he graduated with his bachelor of science degree in Education on June 4, 1951. When the Korean War broke out, Pogue knew he would be drafted, so instead he decided to enlist in the U.S. Air Force.

After serving as an aviation cadet, Pogue completed his flight training and was commissioned a 2nd Lt. in the USAF on October 25, 1952. He then operated as a fighter bomber pilot in the 5th Air Force in Korea, where he flew on 43 combat missions in the six weeks prior to the signing of the armistice, bombing trains and providing air support for troops on the ground. The Korean War came to an end on July 27, 1953. On his return to the United States, Pogue served as a gunnery instructor at Luke AFB, Arizona, ahead of being temporarily assigned as an aerobatic pilot with the Thunderbirds, a magnificent, close-formation air demonstration team, for two years from 1955.

In his 2008 book, *Rupert Red Two*, Jack Broughton relates an amusing story about Bill Pogue at a Seattle Seafair show during that time. “We were the last event on the schedule of the three-day show, and as we pitched up to land, the announcer said that the Thunderbird solo man, Lt. Bill Pogue, would now shoot down the flag with a real, live supersonic pass. The fascinated crowd paused as Bill lit his burner and started a smooth, descending left turn toward the runway. Passing through Mach 1.1, he took out most of the shelves and containers in two local supermarkets. Next came all the glass windows of the airfield control tower. The boom, and Bill, rolled across the crowd, and they loved it, and headed for home.” [**34**]

As Major Broughton also recorded in the January 1958 issue of *Popular Mechanics* magazine, “With all hazards and split-second precision required in formation aerobatics, it would be remarkable if the Thunderbirds didn’t have an incident to remember. Bill Pogue won’t forget the day when his entire electrical system went out during a show, leaving him without anything – including landing-gear power. He dropped away, shot a flameout pattern and landed hot. On top of everything else, his drag chute failed. Fortunately, he made the runway, which was a long one, and skidded to a halt just a few feet from the end.” [**35**]

After leaving the Thunderbirds in 1957, Pogue was given his choice of assignments and he opted to further his education, subsequently attending Oklahoma State University, where he achieved his master’s degree in Mathematics on May 29, 1960. He next took up the role of Assistant Professor in the mathematics department at the Air Force Academy in Colorado Springs. In 1963, midway through this five-year tour of duty, he decided he would like to work towards his ambition of becoming an astronaut with NASA.

As a result of his decision, the next step in Pogue’s life came with an assignment to the Empire Test Pilots’ School (ETPS) in Farnborough, England. As recorded in Douglas Hawthorne’s *Men and Women of Space*, “Through September 1965, he participated in an exchange program between the British Royal Air Force and the U.S. Air Force, as a test pilot with the Royal Aircraft Establishment of the British Ministry of Aviation.” [**13**]

Returning home in October 1965, Pogue became an instructor at the ARPS at Edwards AFB, California. It was while he was at Edwards that he learned of NASA's plans to recruit a fifth group of astronauts and volunteered for selection. After undergoing all the tests and interviews, he was eventually selected as a member of NASA's Group 5 astronauts in April 1966.

STUART A. ROOSA

As Command Module Pilot of Apollo 14, Stu Roosa wrote his name in the history books as one of only 24 men to fly to the Moon during Project Apollo and one of just seven astronauts to fly solo in lunar orbit. Roosa was also present for two other key assignments in early U.S. manned spaceflight history, both highly emotional. He served as Capcom for the twelfth and final launch of the highly successful Gemini program in November 1966 and was then on Capcom duty again two months later, during the tragic Apollo 1 pad fire which claimed the lives of astronauts Virgil I. 'Gus' Grissom, Edward H. White II and Roger B. Chaffee.

Stuart Allen Roosa was born at the Mercy Regional Medical Center in the picturesque railroad town of Durango, Colorado, on August 16, 1933, to Dewey and Lorine (née DeLozier) Roosa. He was only born there through happenstance, as his father was then working as a surveyor for the Bureau of Land Management, which meant that the family lived in several different places before finally settling in Claremore, Oklahoma, when Roosa was still only a baby.

He took his education at Justus Grade School and Claremore High School, graduating on May 22, 1951. He grew up with a love of hunting and the outdoors that was always an important element in his life story, while another early passion was building model airplanes. After high school, Roosa studied engineering at Oklahoma State University and the University of Arizona over the next two years, during which time he also worked for the U.S. Forest Service in Oregon as a "smoke jumper" – someone who parachutes into remote areas to combat wildfires. [36]

"Stuart went through rookie training fine and handled everything better than most, except for tree-climbing classes," recalled colleague Jimmy Dollard in a 2005 interview on the National Smokejumper Association website. "Strange as it might seem for someone who later became a jet pilot and an astronaut, he was afraid of heights. He finally passed the tree-climbing by sheer determination." [37]

Smoke jumping was a lonely, tough and dangerous job, but one that imbued in Roosa a mental toughness and independence of spirit. He dropped into at least four active fires in Oregon and California during the 1953 fire season, earning for himself the lifelong nickname "Smokey."

Now filled with an ambition to become a military fighter pilot, Roosa entered active service with the U.S. Air Force on December 31, 1953. He then attended Gunnery School at Del Rio AFB, Texas, and Luke AFB, Arizona. Next, he applied to join the Aviation Cadet Program at Williams AFB, Arizona. During his psychology induction interview at the academy, he was asked what he had been doing when he applied. Roosa said that he had been a smoke jumper, and when the examiner asked him to explain, he did. As Roosa spoke, the man stared in disbelief and finally said, "Okay, you shouldn't have any trouble with flight training." The planned one-hour interview was completed within ten minutes. [38]

Roosa graduated from the academy and received his flight training commission on March 30, 1955. He was then assigned as a fighter pilot to Langley AFB in Virginia, where he flew Republic F-84F *Thunderchief* and North American F-100 *Super Sabre* jet aircraft, training to deliver nuclear weapons into the heart of the Soviet Union. While stationed at Langley, he met his future wife, Joan Carol Barrett, a seventh-grade history teacher. They were married in 1957.

Under the sponsorship of the Air Force Institute of Technology (AFIT), he then attended the University of Colorado and was awarded his bachelor of science degree in Aeronautical Engineering, with honors, on August 26, 1960. Over the next two years, he would serve as chief of service engineering at Tachikawa Air Base, in the western part of Tokyo, Japan. Then, from July 1962 to August 1964, he was a maintenance flight test pilot at Olmstead AFB, Pennsylvania, flying McDonnell's F-101 *Voodoo* jet aircraft.

The next step in Roosa's flying career was a much-coveted selection to attend the ARPS at Edwards AFB, California, graduating in September 1965. The 12-strong Class 64C also included two future NASA Group 5 astronauts – Charlie Duke and Al Worden – and Hank Hartsfield, who would become a member of the Group 7 astronauts. By the time he was selected by NASA, Roosa had logged 5,500 hours of flying time, including 5,000 hours in jet aircraft.

JOHN L. SWIGERT, JR.

Barbra Zuanich-Friedman is a California-based marketing and public relations consultant and freelance writer. A good friend of Jack Swigert, they stayed in touch until two weeks before his untimely death in December 1982. She once recalled a man she greatly admired.

"He was always the epitome of good manners. He was shy, good-humored, optimistic and intense. I learned about his love for flying that captured him at age 14 and never let go. When he was given the Apollo 13 assignment, he had flown for 24 of his 38 years and brought more than 6,000 flight hours to the mission. For the record, he was uniquely qualified to step into the difficult job of maneuvering Apollo 13's command ship Odyssey. *As a member of the Air Force, he flew fighter jets in Korea and Japan for three years. He was a jet fighter pilot for both the Massachusetts and Connecticut air national guards and was an engineering test pilot for North American Aviation and Pratt & Whitney before joining NASA in 1966. He was a member of the support crews for both Apollo 7 and 11. He held three college degrees, including a master of science in Aerospace Science. He was an associate fellow of the Society of Experimental Test Pilots and a member of the American Institute of Aeronautics and Astronautics. Never before had a backup astronaut been thrust into a leading role on such short notice."* [39]

John Leonard (Jack) Swigert, Jr. was born on August 30, 1931, in Denver, Colorado, the son of an ophthalmologist who urged his son to follow him into medicine although, as his mother Virginia later stated, he had no desire to be a doctor: "He was interested in mechanical things and would rather tinker with an old car than anything else." He attended the Blessed Sacrament School and Regis Jesuit East High School and began flying airplanes at the age of 13, paying for flight lessons with the proceeds of his paper route. He then took on studies at the University of Colorado, where he also played varsity football. Following his graduation with a bachelor of science degree in Mechanical Engineering, Swigert joined the U.S. Air Force, serving from 1953-1956. After completing the pilot training program at Nellis AFB, Nevada, he was assigned a tour as a fighter pilot in Japan and Korea. In 1953, his plane crashed into a radar unit on a Korean airstrip and burst into flames, but he escaped without injury.

After leaving active service, he operated as a research engineering test pilot for Pratt & Whitney in Connecticut. During this time, from September 1957 to March 1960, he also served as a jet fighter pilot with the Massachusetts Air National Guard, then later with the Connecticut Air National Guard from April 1960 to October 1965. In 1962, and again in 1963, he was an unsuccessful NASA astronaut finalist, rejected both times due to his lack of test pilot experience or advanced schooling. For two years, from 1964, he was an engineering test pilot for North American Aviation. One of his assignments was demonstrating the Rogallo wing as a feasible ground landing system for returning space vehicles and astronauts, for which he was named co-recipient of the AIAA Octave Chanute Award for 1966.

In 1965, Swigert earned a master of science degree in Aerospace Science from Rensselaer Polytechnic Institute in New York and in April 1966, became one of nineteen finalists accepted by NASA in their fifth astronaut class. He earned a further master's degree in Business Administration from the University of Hartford, Connecticut in 1967.

PAUL J. WEITZ

Naval aviator 'PJ' Weitz (pronounced "whites") flew two very different missions a decade apart. Following support work on several Apollo missions, it has been suggested that he was in line to be Command Module Pilot for Apollo 20, though the mission was cancelled before any crew was formed or formally identified. Transferring to the Skylab program in 1973, Weitz, together with Commander Pete Conrad and Science Pilot Joe Kerwin, completed a record breaking 28-day mission and also worked to bring the damaged orbital workshop back into working order following a mishap during the launch of the unmanned space station. Then, ten years later, he commanded the sixth Space Shuttle mission and the maiden flight of OV-099 Challenger, *deploying an important NASA data relay satellite and supporting the first EVA from a Space Shuttle by Story Musgrave and former MOL astronaut Don Peterson. 'PJ' Weitz was always a passionate flyer and although he never had the opportunity to return to space for a third time, his two missions were the culmination of a life absorbed in flying.*

"I was an impressionable young lad during World War Two," Paul Weitz stated when asked how he first became interested in aviation during an interview for NASA's Oral History program. "My father was a chief petty officer in the Navy and in World War Two was in the Battle of Midway and the Battle of [the] Coral Sea. I was biased toward [the] Navy anyway, and aviation in general, and just decided at that time, at a very young age, that I wanted to be a naval aviator, and that desire stayed with me. So it's from the time I was ten, eleven, twelve years old." [40]

Paul Joseph Weitz is from Hungarian stock. His paternal grandparents Peter and Eszter (nee Keszler) left Hungary and emigrated to a new life in the United States. There they would raise five children, including Peter Joseph Weitz (who it seems always preferred to be called Paul). Unlike his four Hungarian-born older sisters, PJ's father was born in North Braddock in Allegheny County of Pennsylvania – a county known as 'the birthplace of steel'. He, in turn, married Violet Pearl McClymont, and they would have three children, including the future astronaut.

Paul Weitz was born on July 25, 1932, in the manufacturing port city of Erie in northwestern Pennsylvania. Like his two siblings, young Paul attended McKinley Elementary School on East 22nd Street, before later taking on studies at the nearby Harbor Creek High School. He would graduate first in his class of 63 students on May 26, 1949. While in high school, he met and dated Suzanne Margaret Berry, who would later become his wife.

After leaving high school, Weitz received a NROTC scholarship to Pennsylvania State University, where he earned his bachelor of science degree in Aeronautical Engineering and a commission as a naval ensign.

At Penn State, he also attempted to continue a football career which had started in high school, playing center. However, he injured a knee during his sophomore year and decided to hang up the pads. He graduated from college on January 27, 1954, but said that while at Penn State he received some poor advice.

"Perhaps misguided at the time, I had intended to make a Navy career. I had an instructor at the ROTC unit there, who said as long as I was going to do that, I ought to go to sea first. So I did go to sea, on a destroyer off the West Coast for about a year and a half, before I went to flight training." He found himself assigned to destroyer duty aboard the *USS John A. Bole* (DD-755) as the CIC (Combat Information Center) officer. "It's one of those experiences you look back on, and I'm not sorry I did it," he added, "but I wouldn't do it again, because it put me a year and a half behind my contemporaries who got their commission either out of colleges or the [U.S.] Naval Academy and went directly into flight training." [40]

Asked about his desire to fly with the Navy, Weitz told a reporter, "One reason I wanted to be a naval aviator was to fly off ships. That separates the men from the boys. It's more demanding and you have to bag a little more gear – be sharper – to do it." [41]

Weitz was finally assigned flight training at NAS Corpus Christi, Texas, achieving his Wings of Gold as a naval aviator in September 1956, some three months after marrying Suzanne Berry on June 23. Next, he was sent to Attack Squadron 44 (VA-44), known as the 'Hornets', based at NAS Jacksonville, Florida. He would spend the next four years with the squadron as a Douglas A-4 *Skyhawk* tactics instructor. During that time, he befriended another future astronaut, Alan Bean, who had joined the squadron 18 months before Weitz.

It was while he was at Jacksonville that Weitz narrowly missed death in an airplane accident. Taking an instrument flying refresher course, he was flying 'blind' under a hood in a two-seater jet while an instructor was seated in the front cockpit. There was another instrument training plane nearby. "We knew the other plane was in the vicinity," Weitz said later. "My instructor wanted to look for him, so we did. We found him." The planes collided, wing tip to wing tip. The second plane landed safely, but Weitz and his instructor were forced to bail out. "We lost about half our airplane so we both ejected," he said. "It wasn't uncomfortable except I went through the top of a Florida pine tree. Got scratched up a little bit." [42]

After he had served his four years with VA-44, Weitz applied for test pilot school, but to his disappointment was not accepted. His next move was to Air Development Squadron VX-5, in the Mojave Desert at China Lake, California. "Then … after I got there, I was informed that I'd been selected for the next class at test pilot school. But [the] Bureau of Naval Personnel, the people who detail people and provide them money for the move, said that I had just been moved from the East Coast to the West Coast and they weren't going to move me back to the East Coast again.

"But the VX-5 was excellent duty, as far as I was concerned. I was a project pilot. Air Development Squadron 5 developed air-to-ground weapons delivery tactics for the Navy. I flew five different kinds of airplanes – which people don't do anymore – while I was there, four or five flights a day, albeit short flights, but they were four or five flights a day. So that was an excellent two-year tour for me." [40]

Then he received orders to attend the Navy's Postgraduate School in Monterey, California, which he had not applied for. "I didn't want to go, because I had what I thought was a good job. I had no desire to go back to school. That's one of those turning points, one of those branches, but I had no choice." [40]

He would graduate from the Navy Postgraduate School in June 1964 with his master's degree in Aeronautical Engineering, after completing a three-year course in just two years. In company with another student, future astronaut Jack Lousma, he had talked to a couple of sympathetic professors, and by doing some extra work and study they both managed to graduate with their degrees a year early.

Although he would have preferred a different assignment, in June 1964 Weitz was sent to NAS Whidbey Island in Washington State's Puget Sound, flying the Douglas A-3 *Skywarrior* with Heavy Attack Squadron 4 (VAH-4). He then completed a combat tour from June to November 1965, operating 120 bombing and refueling missions over southeast Asia, flying an A-3 off the carrier *USS Independence* (CV-62). He earned five air medals and then a special Navy Commendation Medal for what was described as "a tricky bit of flying" that saved an Air Force pilot and his flak-damaged airplane.

While the squadron was deployed to the western Pacific, Weitz received an interesting message from the Bureau of Navy Personnel. In it, he was told that NASA was seeking applications for a new group of astronauts, and as he met the Navy's criteria and the space agency's qualifications, he was being given the chance to apply. He responded in the affirmative, and on his return went through the selection process.

Successful NASA Group 5 candidates from Edwards AFB (L to R): Fred Haise, Ed Mitchell, Charles Duke, Al Worden and Joe Engle. (Image courtesy Ed Hengeveld).

ALFRED M. WORDEN

In 2011, at the 40th anniversary celebration of the flight of Apollo 15, Neil Armstrong reminded an appreciative audience at the Kennedy Space Center of the many significant contributions made by Command Module Pilot Al Worden to ensure the complete success of that mission, which he called "a very challenging job." As Armstrong further noted, "The media continually missed or neglected the importance and the difficulty of the CMP's job, but all of us here tonight certainly cannot miss it." [43] *If life had taken some different turns when he was young, Al Worden might be recognized today as an accomplished jazz pianist – his early ambition. Instead, he found fame as the CMP on Apollo 15 who* *performed the first EVA in deep space, spacewalking outside Command Module* Endeavour *nearly 200,000 miles (321,869 km) from Earth.*

Alfred Merrill Worden was born into a farming family living just outside Jackson, Michigan, on February 7, 1932. He was the first son born to Merrill Bangs Worden and the former Helen Crowell, after their daughter Sally had been born a year earlier. There would be four more children over the years – Carolyn, Jim, Jerry and Peter. Their father found occasional jobs as an electrician and instrument technician, but chiefly strived to make a living on their small farm.

In his 2011 memoir, *Falling to Earth*, Worden said he had no real interest in flying as he grew up. "My first memory of airplanes comes from when I was about four years old. One day, a twin-engine aircraft from a little nearby airport had an engine problem and made an emergency landing in the pasture below our house. It hit a fence and skidded to a stop in the grass right next to the railroad track. They had a hell of a job hauling that airplane out of the field, and I remember running down to watch them in wonder. The experience made quite an impression on me. Yet I never thought about aircraft again until I was at West Point." [44]

After attending Dibble, Griswold and Bloomfield grade schools, Worden continued his education at East Jackson High School. A good pupil, he became president of the student body in his senior year before graduating in 1950. He was also a boy scout, achieving the rank of First Class. The school principal at East Jackson, Earl Holman, helped him obtain a year-long scholarship to the University of Michigan, following which he decided to seek admission to West Point military academy. He was accepted, and when he graduated with his bachelor's degree in Military Science on June 7, 1955, he had to choose which service he would enter. At the last possible moment, he elected to join the U.S. Air Force.

"I eventually decided to go into the Air Force, not because I wanted to fly, but because I thought the promotions would be quicker there, which turned out to be a mistake," Worden told NASA interviewer Rebecca Wright. "The Army had much quicker promotions. But I decided to give flying a chance. I'd never had any real interest in it up until then." [45]

During his time at West Point, Worden met an attractive girl named Pamela Vander Beek on a blind date. They became a couple, and were married two days after his graduation ceremony. Now a commissioned 2nd Lt. in the Air Force, Worden received his initial flight training at Moore Air Base in south Texas, flying T-34 *Mentor* and T-28 *Trojan* propeller-driven airplanes, then moved to Laredo AFB (also in Texas) where he learned to fly the Lockheed T-33 jet trainer, and finally to Tyndall AFB, Florida, where he became an all-weather interceptor pilot in F-86D *Sabre* jets.

From March 1957, Worden was assigned to the 95th Fighter Interceptor Squadron at Andrews AFB, Maryland. With little flying to do, Worden took a keen interest in aircraft armaments and maintenance, and in May 1961 was assigned as a flight proficiency officer at Selfridge AFB, Michigan. He also began attending the Horace H. Rackham School of Graduate Studies at the University of Michigan and would achieve two degrees in 1963: his MSE in Aeronautical and Astronautical Engineering, awarded on 8 June, and a second MSE in Instrumentation Engineering on August 17. Later that year, he also graduated from the Instrument Pilots' Instructor School at Randolph AFB, Texas.

In 1964, Worden was sent to England to attend the ETPS at Farnborough, as an exchange officer with the Royal Aircraft Establishment. Having graduated second in his class, he returned home in February 1965. Then, at the specific request of Chuck Yeager, who was commandant of the ARPS at Edwards AFB, California, he joined ARPS Class 64C. He would graduate from that school in September 1965 and remain at Edwards as an instructor.

One excellent facility they had at Edwards was a spaceflight simulator, which could offer astronauts strapped into it a training experience similar to spacewalking, as discussed by Worden in his 2011 memoir. "One week, a couple of astronauts from NASA showed up to practice on it, and I was asked to help instruct them. Gene Cernan and Charlie Bassett were assigned to the forthcoming Gemini 9 mission; Bassett planned to make a spacewalk, and Cernan was training as his backup. Charlie had been through the test pilot school at Edwards himself only a few years earlier and he impressed me right away … Meeting him made me think how good it might be to join the astronaut group at NASA." [**44**]

CLASS OF '66

These nineteen men comprised NASA's Astronaut Class of 1966, the fifth selection in six years, and the fourth (and to date final) selection where the focus right from the beginning was on piloting skills. As a group, their active participation in the space program would span from the closure of the fast-paced Gemini program, across the glory years of the Apollo era and on to the first decade of Shuttle flight operations, even to the difficult years of Space Station *Freedom*. As part of a period of history unlikely to be surpassed by any other NASA astronaut selection, they would experience huge celebrations supporting the first men flying around the Moon, and those walking on its surface. Only four of their group would achieve that feat, although another quartet was in line to join that select few before the budget axe fell. There would also be tragedies, with the loss of the Apollo 1 crew and that of Shuttle *Challenger*. In addition, they experienced the near catastrophe of Apollo 13, which – with their expert help – transformed a potential disaster into what has subsequently been described as NASA's greatest triumph of survival in space.

Members from this selection would support, back up or fly on every Apollo mission, whether in Earth orbit, to the Moon or a space station, as well as helping to forge a partnership with the Soviets. Those who remained after Apollo now became the seasoned veterans for early Shuttle crews, with many moving on to managerial or consultancy roles in the space agency or industry. Here, the inherent talent and dedication that helped in their selection as astronauts now found a new application in supporting the expansion of the Shuttle program, the drive to create a huge station in space, initially called *Freedom*, but known today as the International Space Station, and in support of aerospace and defense industries.

The nineteen may not have been the first American astronauts, nor were they some of the heroic characters associated with those heady early years. But from this group of men came some of the first 'long term' career astronauts and managers, who created the impetus to reach far beyond the Moon towards long duration spaceflight and international cooperation, pushing the boundaries of space exploration for those who followed in their steps. This, then, is their story.

References

1. ***NASA Astronaut Biographical Data Book, Group 5***, April 1983, David J. Shayler, AIS Publications
2. Colin Burgess interview with Vance Brand: Spacefest V, Tucson, Arizona, May 26, 2013
3. Email from Vance Brand, December 23, 2016
4. E-mail to authors from Scott Bull, July 29, 2011
5. NASA Biographical Data, Astronaut John Sumter Bull, Ph.D., December 2008 (www.jsc.nasa.gov/Bios/htmlbios/bull-js.html)
6. *The Whirlybird of HC-2, NAS Lakehurst, NJ*: http://twaintimes.net/hu-2/wbsep65.html
7. NASA News Release: MSC 66-22, April 4, 1966
8. *Kingsport Times*, Tennessee, April 5, 1966
9. Jerry Carr: interview by Kevin M. Rusnak for NASA's Oral History Project, Huntsville, Arkansas, October 25, 2000
10. ***Moonwalker***, Charlie and Dotty Duke, Oliver Nelson Publishers, Cambridge, Ontario, 1990
11. Charles Duke: interview by Doug Ward for NASA's Oral History Project, Houston, Texas, March 12, 1999
12. *Nashua Telegraph* newspaper (New Hampshire) unaccredited article, "Astronaut Charles Duke Described as 'Straight American'," issue April 12, 1972, p. 14
13. ***Men and Women of Space***, Douglas Hawthorne, Univelt Inc., Publishers, San Diego, CA, 1992
14. ***The X-15 Rocket Plane: Flying the First Wings into Space***, Michelle Evans, University of Nebraska Press, Lincoln, NE, 2013
15. ***Hypersonic: The Story of the North American X-15***, Dennis R. Jenkins, Specialty Press, Forest Lake, MN, 2008
16. ***Fallen Astronauts***, Colin Burgess and Kate Doolan, University of Nebraska Press, Lincoln, NE, 2003
17. Lunar Pioneer website article, "Into Space: Fred Haise lecture series in Alabama," February 19, 2009. Available at: http://lunarnetworks.blogspot.com.au/2009/02/into-space-fred-haise-lecture-series-in.html
18. *The Pittsburgh Press* (Pennsylvania) newspaper article, "Fred Haise: Journalist-Astronaut," issue April 7, 1970, p. 19
19. *Eugene Register-Guard* (Oregon) newspaper, April 12, 1970, "Fred W. Haise," p. 5A
20. Irwin quotes from ***To Rule the Night***, Holman Bible Publishers, Nashville, TN, 1982
21. *Astronautica Encyclopedia, "Astronaut Statistics."* Available online at: http://www.astronautix.com/articles/aststics.html
22. Don Lind: interview by Rebecca Wright for NASA's Oral History Project, Houston, Texas, May 27, 2005
23. ***Don Lind, Mormon Astronaut***, Kathleen Maughan Lind, Don Lind, Deseret Book Co., Salt Lake City, UT, 1985
24. Jack Lousma: interview with Colin Burgess, Tucson, AZ, May 23, 2013

25. Jack Lousma: interview with Carol L. Butler for NASA's Oral History Project, Houston, Texas, March 7, 2001
26. Simon Vaughan chapter, "Worth the Wait" from ***Footprints in the Dust***, (ed. Colin Burgess), University of Nebraska Press, Lincoln, BE, 2010
27. Charles Postell and Lee Holley, *The Free Lance-Star* newspaper, Fredericksburg, Virginia, article, "Ken Mattingly: Bachelor in Space," issue April 4, 1970, p. 14A
28. Thomas K. Mattingly II: interview by Rebecca Wright for NASA's Oral History Project, Costa Mesa, California, November 6, 2001
29. Wikipedia entry, "Bruce McCandless," available online at: https://en.wikipedia.org/wiki/Bruce_McCandless
30. Ed Mitchell: interview by Nick Margerrison for Kerrang Radio (London, England), July 23, 2008
31. Matt Schudel, *Sun Sentinel* (Ft. Lauderdale, FL) newspaper article, "The Dark Side of the Moon," issue January 3, 1988
32. Brienne Green, *Artesia Daily Press* article, "Remembering a Hometown Hero," issue February 7, 2016
33. Edgar Mitchell: interview with Sheree Scarborough for NASA's Oral History Project, Houston, Texas, September 3, 1997
34. ***Rupert Red Two: A Fighter Pilot's Life from Thunderbolts to Thunderchiefs***, Jack Broughton, Zenith Press, Minneapolis, MN, 2008
35. U.S. Air Force Major Jacksel M. Broughton, "I Led the Thunderbirds," *Popular Mechanics* magazine, issue January 1958, p. 131
36. ***Smoke Jumper, Moon Pilot: The remarkable life of Apollo 14 astronaut Stuart Roosa***, Willie G. Moseley, Acclaim Press, 2011
37. Elizabeth Howell, Space.com contributor, "Stuart Roosa: Apollo 14 Command Module Pilot," *Space.com*, March 26, 2013. Available at: http://www.space.com/20392-stuart-roosa-biography.html
38. Philip Baker chapter, "Science, and a Little Golf," from ***Footprints in the Dust*** (ed. Colin Burgess), University of Nebraska Press, Lincoln, NE, 2010
39. Barbra Zuanich-Friedman email to Colin Burgess, January 14, 2014
40. Paul Weitz: interview by Rebecca Wright for NASA's Oral History Project, Flagstaff, Arizona, March 26, 2000
41. *The New York Times* newspaper article, "Pilot in Search of New Frontier: Paul Joseph Weitz," issue May 26, 1973
42. *The Bee* (Danville, VA) newspaper article, "Astronaut Paul Weitz Has Driving Force," Issue May 9, 1973, p. 24
43. Neil Armstrong: speech given 26 July 2011 at the Kennedy Space Center, Florida to mark the 40th anniversary of the Apollo 15 mission
44. ***Falling to Earth***, Al Worden with Francis French, Smithsonian Books, Washington, DC, 2011
45. Al Worden: interview by Rebecca Wright for NASA's Oral History Project, Houston, Texas, May 26, 2000

3

The 'almost' astronauts

"It is hard to fail, but it is worse never to have tried to succeed."
Spoken in 1912 by Theodore Roosevelt (1858-1919),
26th President of the United States (1901-1909),
after losing the 1912 Presidential Election.

Those fifteen words aptly sum up the disappointment of failing to achieve a long-held ambition. Yet, perhaps with hindsight, there can be some satisfaction in at least trying to attain that goal rather than not even attempting to reach it. It is a lesson that can be applied in many fields of human endeavor, and as words of wisdom to younger generations.

The joy of their success for the 19 young pilots who were named to NASA's fifth class of astronauts in the spring of 1966 contrasted sharply with the feelings of those who had strived to beat the odds but did not succeed, in what was ultimately their final chance to reach space. Though unclear at the time, it would be another decade before NASA looked to add to the ranks of their astronaut program. Nevertheless, there was cause for optimism for a while. In 1967, a new class of scientists were chosen, none of whom had any military jet flying experience. Two years later, seven former Manned Orbiting Laboratory (MOL) astronauts transferred to NASA, although they had been selected under the USAF criteria.

By the early 1970s, it became clear that NASA's grand plans – for more lunar flights, a series of orbital workshops, and enormous space bases crewed by up to 100 people – would progress no further than the study reports which generated them. There remained a slim chance for those wanting a flight, thanks to a new, winged vehicle called Space Shuttle, but that would be several years in development. By the time it was ready, all those who had applied during the 1960s for NASA's astronaut training and had not been successful were either too old, had hung up their flying goggles, or were deceased. By the second half of the 1970s, NASA was looking for a different generation of astronauts to those who had been selected or had missed out in the previous decade.

D.J. Shayler, C. Burgess, *The Last of NASA's Original Pilot Astronauts*,
Springer Praxis Books, DOI 10.1007/978-3-319-51014-9_3

From the original 5,000 who answered the call for new astronauts in 1966, a total of 351 emerged who at least met the basic requirements. Of those, 159 names were nominated for further consideration and, ultimately, just 44 progressed to the final steps. For the remaining 115, this proved to be their final chance to add the job description 'NASA astronaut' to their *curriculum vitae*.

DESPITE THE ODDS

One of the 5,000 applications received by NASA came from a determined young U.S. Navy lieutenant named Frank K. Ellis, a 32-year-old amputee who had lost both his legs in the crash of a Grumman F-9 *Cougar* three years earlier, on July 11, 1962. In over 50 years of astronaut selections and thousands of hopeful applicants, the story of Frank Ellis, although ultimately unsuccessful in his bid to join the astronaut corps, stands out as a remarkable account of patience, persistence, and sheer guts, similar in many ways to the heroic story of legless British fighter ace Douglas Bader, and reflective of the so called 'Right Stuff' such pilots are made of.

Lieutenant Frank K. Ellis, USN

Born in Painesville, Ohio, in 1933, Frank Ellis joined the naval Reserve Officer Training Corps (ROTC) program at the University of Colorado, graduating in 1956. After receiving his commission as a Navy ensign in September that year, he undertook flight training and was awarded his wings as a naval aviator on December 6, 1957. "My first fleet duty began in September 1959 with an assignment to VF-21, an all-weather night fighter squadron flying the F3H *Demon* aboard the *USS Midway* [CVA-41]," he recalled. [1] Later, he would fly the F9F *Cougar*, as a pilot with Aircraft Ferry Squadron 32 (VR (F)-32), based at Naval Air Station (NAS) North Island, San Diego.

On the afternoon of July 11, 1962, following a routine delivery flight from Norfolk, Virginia, he was beginning a nominal landing approach at NAS Point Mugu in California. He lowered his landing gear, set his flaps, and called the tower, but as he did so he noticed the jet's nose had begun to dip down. He was adjusting the trim with his control stick when the airplane suffered a crippling failure in the elevator trim system and began to hurtle nose-down to the ground. Ellis desperately hauled back on the stick, but to no avail, and a crash seemed inevitable. He was still at 300 feet – high enough to have safely ejected – and he reached for the face curtain above his helmet, ready to pull it down to cover and protect his face during the ejection. As he did so, he noted to his horror that some on-base housing and a trailer camp filled with civilians was directly in the jet's projected flight path. He knew he could not allow an unpiloted airplane to hit this populated area and, despite the imminent danger to himself, elected to try and steer the wayward jet somewhere safer. Reacting instinctively, he raised the landing gear and threw on power. Following a mighty effort, he finally managed to maneuver the *Cougar* toward a lemon grove, and only then did he prepare to eject. Unfortunately, he was at an extremely low altitude when he triggered his ejection, later judged to be just 65 feet off the ground, well below the 325 feet minimum height for a safe ejection. As he was jettisoned out through the Plexiglas cockpit, he had a momentary sensation of being hurled into the massive fireball created when the jet slammed into the ground and exploded.

His parachute never had a chance to open fully as he flew through the air, and he finally smashed into a grove of eucalyptus trees, which broke his fall somewhat, before tumbling 45 feet to the ground and landing unconscious in the lemon grove.

His high-speed impact with the trees and ground caused Lt. Ellis several severe injuries. His lower back was broken, he fractured three ribs, and there were minor burns on his face and hands. Crash crews were quickly on the scene and saw that his left leg was badly mangled (it was broken in three places), while the right leg had been sliced off some nine inches below the knee. Through his actions, he had undoubtedly saved many lives, but he would now face the fight of his young life to survive. Although the doctors and surgeons at St. John's Catholic Hospital in Oxnard, California, held out little hope of saving him early on, his mighty courage and excellent physical condition saw him through the immediate recovery period. Unfortunately, three weeks later, he would also lose his severely-damaged left leg.

At first, Ellis steadfastly refused to take any pain-killing drugs, even though the pain in his left leg before it was removed was acute. But he relented after one night when the pain became so intense that he was found repeatedly banging his head against the pillows in agony. Once the leg was finally amputated, the pain and emotional trauma quickly began to recede: "The amputation itself came as quite a relief after so much fever, loss of weight, immobility and pain," he later revealed. [2]

Following the amputation, Ellis began a steady path to recovery, both physically and mentally: "I was just so grateful to be alive," he reflected. "I should have died in the crash, no question." [3]

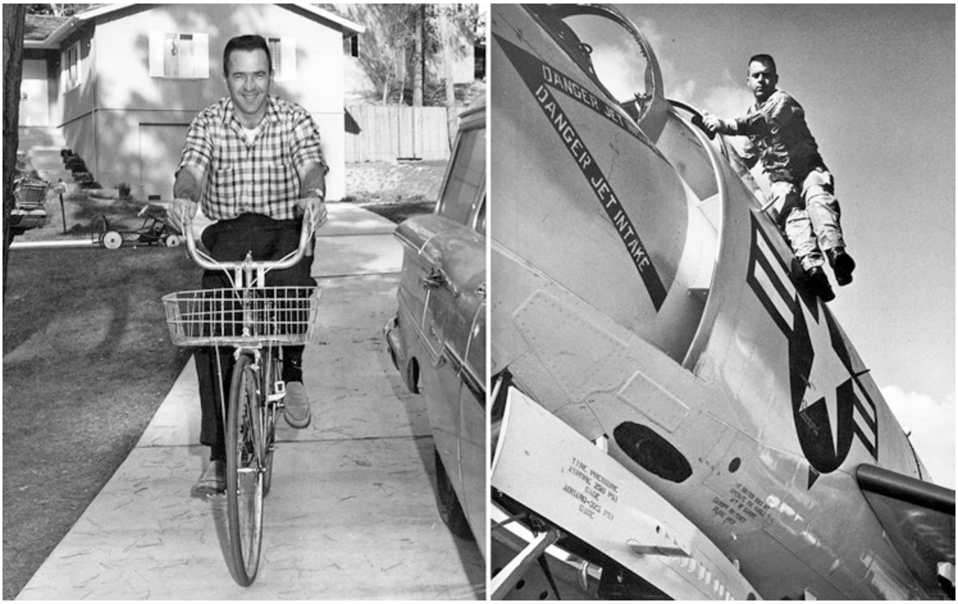
In December, he was fitted with his first pair of artificial legs, carved out of willow. Two years after the accident, he was awarded the Distinguished Flying Cross (DFC) "for heroism" on that July afternoon, with the presidential citation reading: "Although sustaining serious injuries, Lieutenant Ellis, by his selfless and decisive action, undoubtedly prevented loss of life and property in the housing area." [4]

Then the next challenge presented itself – to regain flight status with the Navy. "The Navy trained me to be a winner, not a loser," he told *Listen* magazine reporter Eloise Engle. "I only want to serve my country. I'll prove I can do it, too." [5]

Not for him was the grim prospect of leaving the Navy, giving up flying forever, and living an uncertain future life supplemented by a disability pension. He would not only walk again, he resolved, but would one day take to the skies once more.

As he also revealed in a 1963 article for *Life* magazine; "I realized the burden of proof was on me, and that I was going to have to give the brass some pretty dramatic proof before they would let me fly again." [2] A year after the crash, and despite being a double amputee with new artificial legs, Frank Ellis began an intensive physical training course. Refusing to bow to his severe handicap, he took up swimming, underwent a tough water survival test, ran obstacle courses, scaled ropes, and even made a demonstration parachute jump from 2,500 feet with the San Diego Sky Divers. "I twisted my 'right ankle' about 45 degrees on impact," he told *Life*, "but I just took the leg off, twisted the ankle back and was in business once again." [2]

His determination soon won over understandably cautious Navy chiefs and he was granted temporary flight status in Service Group III, albeit flying only dual control aircraft, and only if accompanied by a qualified co-pilot.



Frank Ellis (left) riding a bike near his home, and (right) exiting an F3H Demon aircraft (Courtesy Frank Ellis).

One person who knew Frank Ellis well in the period following his accident was fellow naval aviator Jack Ferrell: "I was in VRF-32 with Frank in 1963 and 1964," he recalled. "First day that I checked into the squadron, Frank came up to me and introduced himself. He said, 'My name is Frank Ellis and I would like to welcome you to VRF-32. I lost my legs in an aircraft crash a few months ago.' Then he turned and walked off without a limp. I said to myself he must have said he had broken his legs. As time went on I heard the full story and that he was awarded a Distinguished Flying Cross for his courage in staying with his jet fighter until the last second, thus saving countless lives.

"My best memory of Frank is when I volunteered to take him as my co-pilot in a TC-45J (a twin-engine airplane used for training and transportation). Frank and I left NAS North Island on June 12, 1963, bound for NAS Pensacola, where Frank would be evaluated as to whether he was capable of flying as pilot in command of naval aircraft. The trip was uneventful until we left El Paso and our right engine started to over-speed. We shut down and feathered the engine and made a one-engine landing at Midland, Texas. At Midland, no one knew how to fix the over-speeding propeller. We finally decided to make a normal take off, putting a load on the right engine, thus keeping the r.p.m. limits within the 'green' lines. When we reached cruise altitude, the engine again over-sped.

Once again, we shut down the engine and feathered the propeller. We could not hold our altitude, so we would drift down to a lower altitude, restart the engine, put a load on the propeller and climb back to our cruise altitude. We did this until we reached Barksdale AFB [Air Force Base] and landed. We decided not to write up the airplane because Frank had a schedule to be evaluated at NAS Pensacola. That afternoon we checked into the BOQ [Bachelor Officers' Quarters] and decided to go for a relaxing swim in the base swimming pool. As we arrived, Frank took off his artificial legs and walked out on the diving boards with his hands and arms doing the walking, and dove off into the water. Needless to say, all mouths were gaping open.

"The next day, we went out to the TC-45J expecting to do our same routine to NAS Pensacola, and for some reason, the propeller had fixed itself and we had a normal flight into Pensacola." [6]

At Pensacola, Ellis began a grueling week of flight and medical tests before a special board of flight surgeons. At the time, a Navy spokesman stated that if Ellis was successful in his bid, it would be the first time a legless American pilot had been given flight status. The recommendation of the board was then sent to the bureau of medicine and surgery in Washington, D.C., where a board of inquiry would adjudicate on the case for his reinstatement to flight status. Following this, the chief of Navy personnel would make a final decision.

Eventually, the decision came through in a phone call from Paul Fay, Jr., the supportive Undersecretary of the Navy. It brought mixed news; Ellis's temporary Group III flight status had been made permanent, meaning that he could only continue to fly dual-control aircraft along with a qualified copilot.

Ellis was bitterly disappointed, as he had been shooting for a solo certification, but it was nevertheless a significant milestone in his devout quest to one day regain his solo status. His next step was to attend the U.S. Naval Postgraduate School in Monterey, California, undertaking a three-year course to achieve his master's degree in Aeronautical Engineering. A sympathetic Undersecretary Fay subsequently wrote to him, saying, "Your recent progress report sounds like the same old Frank Ellis – tenacious, tigerish and talented. As you well know, I admire all your efforts to become restored to full flight status and I sincerely hope that you make the grade. I think your best move would be to continue in your present status – impressing as many people as you can with your flight abilities – and try for a reclassification of your flight status as you approach the end of your schooling. I have prepared a memorandum for the record which endorses your return to group II status upon completion of your postgraduate schooling. Best wishes for continued successes." [7]

While still at postgraduate school, Ellis applied to NASA for consideration as a Group 5 astronaut: "I heard on the radio the other day that the space agency is looking for qualified aviators under 5 feet, 7 inches," he told a reporter at the time. "I'm the only pilot who can vary his height from 5 feet, 4 inches to 6 feet, 1 inch." [2] He also pointed out that the loss of his legs did not impair his flying ability, and that there was no need for legs in the weightlessness of space. "Maybe NASA has a small capsule just big enough for the Navy's shortest pilot," he joked in one interview. "I could leave my legs behind on the launching pad." [1]

For the Group 5 astronaut intake, NASA required the U.S. Navy to submit the names of aviator applicants they felt were qualified to undergo initial scrutiny and medical clearance.

“I learned that I was one of the 50 pilots selected by the Navy,” Ellis later wrote in an article for the spring 1996 edition of *Foundation* Magazine. “However, when the list was sent to the Chief of Naval Operations, my name was no longer on it. A letter sent with the list to NASA [by Adm. David MacDonald] stated that I was not technically qualified for the astronaut program; but from the standpoint of motivation, background, training and experience, [I] would have ranked number five on the list.” [1]

Frank Ellis would later serve as a Management Services Officer and Controller at the Naval Air Rework Facility in Jacksonville, Florida, before retiring from the U.S. Navy on October 31, 1968. He then worked as a financial planner and in real estate. He and Christine, his beloved wife of 60 years, lived in Paisley, Florida, in the years leading up to his passing, on December 27, 2016. He left behind four children and six grandchildren. [8]

“If I had to give a one-word answer describing why all of this has been so relatively easy for me,” he once ventured, “that word would be ‘faith’ – faith in myself, faith in my family, faith in my friends, faith in our American heritage and most important, faith in God. No man walks alone.” [1]

THE TWENTY-FIVE UNSUCCESSFUL GROUP 5 APPLICANTS

Over a six-week period during January and February 1966, a total of 44 men reported to Brooks AFB for a harrowing week of medical tests and evaluations, to determine if they met the strict requirements NASA was looking for in its astronauts. Though there were further tests and evaluations to come, reaching this stage reflected their status of ‘almost’ astronauts; those who reached the final hurdles, but would not be one of the 19 that were ultimately selected. Here, we give brief profiles of the 25 men who almost became members of NASA’s Astronaut Class of ‘66.

Lieutenant Milton (‘Milt’ or ‘Doc’) Harold Bank II, USN

Milton H. Bank II, known as ‘Doc’, was born on August 11, 1935. The eldest son of a Methodist minister, he graduated from Michigan’s Pontiac High School in 1953 and entered the U.S. Naval Academy. As a naval aviator, he was sent to Vietnam with VF-213, reporting aboard the *USS Kitty Hawk* in March of 1967. He flew his first combat mission on March 11. A former Radio Interceptor Officer (RIO) who flew with Milt in Vietnam remembered him as “a rock-solid aviator in all environments.” He received the highest praise, not only for his flying skills but also in his duty as a naval officer and for his personal character. [9] On departing for his second combat cruise, Lt. Cdr. Bank was diagnosed as a diabetic. He was subsequently medically retired from the Navy and returned to civilian life. Bank earned a PhD in Aero-Structures in 1971, and was hired by the Naval Postgraduate School, where he taught in the Aeronautics and Astronautics Department for the next five years. He also served as director of academics at the School of Aviation Safety (SAS). He was internationally recognized for his skills in aviation safety and accident reconstruction, with a rare talent for integrating practical applications with his passion for teaching. He died on May 25, 2010, aged 74.

Lieutenant Commander Peter A. Banks, USN

Born on December 26, 1932, all that is known of Lt. Cmdr. Banks' early life was that in 1962, he was reportedly flying A-4D *Skyhawk* aircraft with Naval Attack Squadron VA-155 (the 'Silver Fox' squadron). After applying for the NASA astronaut program and reaching as far as the medicals at Brooks AFB, he presumably returned to his USN service, but nothing more is known of him.

Lieutenant Harry Lee Blackburn, Jr., USN

Born December 28, 1935 in Ft. Benning, Georgia, Harry Blackburn attended Duke University in Durham, North Carolina between 1954 and 1958. Following his unsuccessful astronaut screening, Blackburn was assigned in 1970 to VF-92 (the 'Silver Kings') for a year, prior to deployment with his unit on *USS Constellation* (CV-64), part of Task Force 77 attached to the 7th Fleet. On May 10, 1972, he launched with his radar intercept officer, Lt. Stephen A. Rudloff in their F4J *Phantom* on a flak suppression mission against the Guan Lang Airfield in North Vietnam. After hitting two anti-aircraft positions, Blackburn was engaging an enemy MiG fighter when his aircraft was hit by ground fire, forcing Rudloff and himself to eject. Other airmen confirmed both men had ejected safely with good parachutes, and landed several hundred yards apart. Both men were initially listed as Missing in Action (MIA), later changed to Captured. Rudloff never saw Blackburn again after his capture, despite assuming he was being interrogated in the next room. He was released as a prisoner of war (POW) in 1973, but Blackburn was not, nor did his name appear on any list provided by the Vietnamese. On April 10, 1986, the Vietnamese returned remains they had 'discovered' which were positively identified as being those of Blackburn. Harry Lee Blackburn, Jr. was promoted to the rank of captain during the period he was detained as a POW. The exact cause and date of Blackburn's death remain unclear. [10]

Captain John David Carlton, USMC

Although born in Acron, Ohio, on July 7, 1933, John Carlton grew up in Texas, graduating from Borger Senior High School in 1951. He attended the University of Texas, graduating with a bachelor of science degree in Civil Engineering and an ROTC commission as a second lieutenant in the U.S. Marine Corps, on June 19, 1956. Following flight training at NAS Pensacola, Florida, and NAS Beeville, Texas, he received his wings on July 16, 1958. He was then assigned to VMA-211, flying the A-4 *Skyhawk*. In May 1963, following a squadron tour in Iwakuni, Japan, Capt. Carlton attended the U.S. Navy's Test Pilot School (TPS) at Patuxent River, Maryland. Later, promoted to major, he joined the 2nd Marine Air Wing (MAW) at Cherry Point, North Carolina. He then served with VMFA (AW)-225 flying A-6 *Intruder* aircraft, and VMFA (AW)-242 at Da Nang Air Base in the Republic of Vietnam, flying 200 combat sorties. He then commanded VMCJ-1, conducting combat operations in Vietnam during *Operation Linebacker*, for which he was awarded the Silver Star on April 16, 1972. Promoted to full colonel in August 1978, he served as Assistant Chief of Staff, G-4, with the 2nd MAW at NAS Cherry Point. Col. Carlton died on September 15, 1992, aged 59, and is interred in Arlington National Cemetery.

Captain Richard E. Cherry, Jr., USAF

Richard E. Cherry Jr. (Dick, to his friends) died at a hospice facility in Merritt Island, Florida, on February 22, 2015, from heart-related illnesses at the age of 82. Born to Richard E. Cherry Sr. and Fannie Moore Cherry on July 28, 1932 in Albany, Georgia, Cherry attended Georgia Tech for one year before entering the United States Naval Academy at Annapolis, Maryland, graduating in 1954. While there, he met the former Carolyn Lewis of Towson, Maryland. Upon graduation, Dick and Carolyn were married. He accepted a commission in the newly formed U.S. Air Force and attended fighter pilot training in Texas. He subsequently served in multiple fighter squadrons and flew F86 *Sabre* and later F4 *Phantom* aircraft, highlighted by two tours in Vietnam where he flew 86 combat missions in support of the war. In between assignments, he attended the Massachusetts Institute of Technology (MIT), where he received a master’s degree in Aeronautical Engineering. Later in his career, Cherry became involved in the Air Force space program, where he served at the east (Patrick AFB) and west (Vandenberg AFB) missile ranges. In 1979, Col. Cherry retired from the Air Force after 25 years of service. Following his retirement from the USAF, Cherry worked for many years at Kennedy Space Center (KSC), for Aerospace Corporation, and was involved in the successful launch of five MILSTAR communication satellites still in operation today.

M.P. (‘Pete’) Frank III

M.P. ‘Pete’ Frank was born in Bryan, Texas, on August 20, 1930. He later stated that the initials M.P. did not represent any given names, and he had always been known as ‘Pete’. He grew up in Denton, Texas, where he graduated from high school in 1948. Following a boyhood interest in flying and airplanes, he attended the University of Texas, Austin, graduating in 1952 after earning a bachelor’s degree in Aeronautical Engineering. For the next four years, he served as a pilot in the U.S. Marine Corps, and following active service he continued duty in the USMC Reserve, eventually rising to the rank of lieutenant colonel. Following his active USMC service, Pete Frank worked for the Martin Company in Baltimore, earning a master’s degree in Mechanical Engineering from Drexel University in Philadelphia. He joined NASA at the Manned Spacecraft Center (MSC), Houston, in 1962, helping to plan the Apollo Moon missions.

Pete Frank was chosen as a Flight Director in Mission Control as a member of the Class of 1968, becoming the 8th person to take the Flight Director’s console during a mission. He adopted the Shift call sign of *Orange Flight*. Frank served as an Apollo Flight Director between 1969 and 1972, specifically for Apollo 9 (Shift 3), 10 (Shift 3), 12 (Shift 2), 14 (Lead FD Shift 1), 16 (Lead FD Shift 1), and 17 (Shift 3). In 1975, he assumed the role of Lead Flight Director/Shift 1 for ASTP. He subsequently became Chief of the Flight Control Division before finally retiring from NASA in 1983 (at which time his *Orange Flight* name was also retired). After leaving NASA, Frank became a FAA Certified Flight Instructor. He died from injuries sustained in a car accident on June 22, 2005, aged 74. His wife of 52 years, Barbara R. ‘Bobbie’ (Rumph) Frank was also seriously injured but survived the accident.

George Furlong, Jr.

George Furlong was born in Muskogee, Oklahoma, on November 23, 1931. A few days after his 17th birthday, while still in high school, he joined the Naval Air Reserve V-6 program. After graduating the following June, he entered active duty with the U.S. Navy, operating as a PBY-5A air crewman (flight engineer) for over a year before being sent to the Naval Training Center in San Diego, California. He then moved to NAS Alameda, before eventually attending Naval Academy Preparatory School (NAPS) at Bainbridge, Maryland, from December 1951 to June 1952. Here, he was an instructor in the 'speedup program,' for students arriving late in the school year before Naval Academy exams. Then, as a fledgling midshipman, he attended the U.S. Naval Academy at Annapolis for four years of study and instruction.

Following his graduation with honors on June 1, 1956, he undertook temporary duty at NAS Pensacola, Florida for three months, prior to flight training there in September and then advanced instruction at nearby Whiting and Barin Fields and at NAS Corpus Christi, Texas. He received his wings as a naval aviator on July 30, 1957, after which he was assigned to VF-121 (the 'Pacemakers') at NAS Miramar, California, flying the Grumman F-11 *Tiger* and North American FJ-3 *Fury*.

In June 1958, Lt. (junior grade) Furlong was sent as a replacement pilot to VA-156 ('Iron Tigers'), serving on board the *USS Shangri-La* (CV-38), before a WestPac deployment as part of Carrier Air Group 11 (CVG-11). In January 1959, the squadron was designated VF-11 (the 'Sundowners'), and Furlong eventually completed two further WestPac deployments prior to July 1961, this time aboard the carrier *USS Hancock* (CV-19).

At the completion of the squadron's second deployment, Lt. Furlong entered U.S. Naval Postgraduate School in Monterey, California, successfully graduating with his bachelor of science degree in Aeronautical Engineering. In June 1963, he began his next assignment, a two-year duty as F-4 (*Phantom II*) Project Officer at the U.S. Naval Weapons Evaluation Facility, at Kirtland AFB, New Mexico. Shortly after commencing this duty, he was selected by the Navy as an astronaut candidate for NASA's Group 3 selection process, but was not one of the 14 eventually chosen. For the next two years, he flew numerous Mach 2-plus test flights in the *Phantom II*, evaluating several weapons at the outer edges of the F-4 envelope.

In November 1965, Lt. Cmdr. Furlong was informed that he had again been chosen as an astronaut finalist, this time in NASA's Group 5 selection. Having been through the process once before, he had high expectations of being selected the second time around. Once again, however, he missed the final cut, and believes it may have been due to his height, at an inch over six feet. By the time the names of the 19 selected astronauts were announced on April 4, 1966, he was on the first of five combat deployments to Vietnam. In June 1966, he was ordered to COMCARDIV NINE (Commander, Carrier Division Nine), as Aide and Flag Secretary. In mid-1967, now with the rank of commander, he reported to VF-142 ('Ghostriders'), flying F-4B/J *Phantom* aircraft over Vietnam; first as the squadron's Maintenance Officer, then Executive Officer (XO) and finally (1970-1971) as Commanding Officer (CO).

From April 1967 to May 1970, VF-142 completed three extended combat deployments to Vietnam on *USS Constellation* (CVA-64), during which time they transitioned from the F-4B to the F-4J. In September 1972, they would once again be deployed to Vietnam, this time aboard *USS Enterprise* (CVN-65). Altogether, Cmdr. Furlong flew 226 combat missions in the F-4 during a total of five deployments to Vietnam and received the Navy

League’s John Paul Jones Award for Inspirational Leadership while serving as commanding officer of VF-142.

His next assignment was as COMNAVAIRPAC’s fighter training officer, but this tour was cut short by orders sending him instead to the Mare Island Naval Shipyard in Vallejo, California, for a six-month course at the Navy Nuclear Power School. After completing the academic phase of the program, he returned to AIRPAC as director of fleet introduction for the F-14 *Tomcat*. This would keep him in constant motion between San Diego, Washington, D.C. and Bethpage, New York, as the project – and aircraft – approached fleet introduction. In mid-1973, he was assigned as COMCVG-14, the first F-14 and S-3 *Viking* air wing commander on board *USS Enterprise* (CVN-65), remaining so until relieved in Hong Kong in late 1974. During this period, he maintained proficiency in numerous aircraft types and carrier qualified in the F-14, A-6, EA-6, A-7 and S-3, becoming the first fleet aviator to day-night qualify in the F-14.

From November 1974 to February 1976, Capt. Furlong commanded the Pearl Harbor-based fleet oiler *USS Ponchatoula* (AO-148), during which time he took the ship through an eight-month WestPac deployment and overhaul. He then commanded the *USS Independence* (CV-62), based in Norfolk, Virginia, later taking the carrier on a seven-month Mediterranean cruise and remaining in command while the carrier was converted to F-14 capability in a complex overhaul at the Portsmouth shipyard, New Hampshire.

From September 1978, after conducting post-overhaul sea trials of the *Independence*, Capt. Furlong served in Gaeta, Italy as Chief of Staff, U.S. Sixth Fleet, until September 1980. His next tour was in Washington, D.C., where he served as OP-50W (ops analysis) from September 1980 to May 1981.

Next, Capt. Furlong assumed the position of commander of the Fighter Airborne Early Warning Wing Pacific Fleet, a command he described as “the most fun of my naval career. The command back then included my HQ base, NAS Miramar, my staff, NAF El Centro, five carrier air wings including 16 fighter squadrons and eight AEW squadrons, Top Gun, one experimental fighter squadron (VX-4), and one composite squadron split between Hawaii and Cubi Point [Philippines]. Naturally, I got to fly with all of them.” In August 1983, he was assigned the role of Deputy Chief of Naval Education and Training, headquartered at NAS Pensacola, Florida. Soon after, his wife Ryland (known as ‘Ry’) began treatment for a serious illness, which resulted in Rear Adm. Furlong retiring from the U.S. Navy on January 1, 1986.

In his service career, he had accumulated some 4,500 flight hours and 930 fixed carrier/ship landings. His many awards include 12 Air Medals (strike/flight), 2 Legions of Merit, two Meritorious Service Medals, 3 Navy Commendation Medals w/combat V and 2 Navy Achievement Medals. Fortunately, his wife recovered from her illness, and over the next decade, Furlong flew small aerobatic aircraft for recreation along with some fighter aviation friends. In 1990, he was inducted into the Arkansas Aviation Hall of Fame.

Following his retirement from the Navy, Rear Adm. Furlong assumed the position of Executive Vice President for the Naval Aviation Museum Foundation, a not-for-profit organization which has built, and supports the development of, the National Naval Aviation Museum in Pensacola. He retired from that position in 1997, although he “re-enlisted” in 2001 to assist in further fund-raising for the Phase IV Museum expansion and the National Flight Academy. [11]

Major John A. ('Jack') Graff, USAF

Born December 24, 1932, Jack Graff grew up in Point Loma and graduated from the U.S. Naval Academy in 1953. He then transitioned into the Air Force and later flew 100 combat missions during the Vietnam War, with 469 Tactical Fighter Squadron (388 Tactical Fighter Wing). He received the DFC "for extraordinary achievement while participating in aerial flight in Southeast Asia on January 16, 1967." He served for 22 years before his first retirement (rank of colonel) and had subsequent careers at Boeing and General Dynamics. Graff died in Escondido, California, on November 8, 2014.

Darryl George Greenamyer

Born on August 13, 1936 in South Gate, California, Greenamyer graduated from Monrovia High School in 1954 before joining the California Air National Guard (ANG). He began his flying career at age 19 with the U.S. Air Force, but after 18 months of active duty, he left the service and was discharged back to the ANG. In 1958, he graduated from the University of Arizona with a bachelor of science degree in Mechanical Engineering. By now, he had logged 1,000 hours of flight time with the U.S. Army and the ANG, flying F-86 *Super Sabre* and F-104 *Starfighter* jet airplanes. In 1961, he began working at Lockheed's 'Skunk Works,' where he conducted test flights on the A-12 and SR-71 *Blackbird*. While at Lockheed, he met several engineers who would later help him to modify race planes. He won his first victory in the Unlimited Class at the Reno Air Races in 1965. He is the third most successful competitor in Reno Air Race history. After the Sport Class was introduced in 1998, Greenamyer built a Lancair *Legacy* (N33XP) that he has since raced successfully. Besides aircraft, Greenamyer has also been active in drag racing.

In 1963, he was accepted into Class 63A of the TPS at Edwards AFB, California. On August 16, 1969, flying a modified Grumman F8F-2 *Bearcat*, he broke the long-standing World Low Altitude Speed Record by flying at 483.04 mph. On October 24, 1977, flying a highly-modified F-104 *Starfighter* dubbed the 'Red Baron,' he broke another speed record by flying at 988.26 mph, a record that still stands today. In February 1978, while preparing an assault on the FAI altitude record using the same aircraft, he was unable to get the landing gear to lock before landing and was forced to eject. The F-104 was destroyed. In 1994, he led an unsuccessful mission to rescue a B-29 aircraft which had crash-landed in Greenland in 1947. The airframe was lost to fire during the attempted recovery. He has also been active in buying and selling aircraft and recovering other unusual airplanes for museums. By 1994, he had accumulated some 16,950 hours of flight time. Today, he lives in San Diego, California, and enjoys his collection of classic Ferrari motor cars.

Major Ernest Leon Hatchell, Jr., USAF

Very little is known about Ernest Hatchell. He was born June 19, 1931, in Charleston, South Carolina and attended flight school at Graham Air Base, Marianna, Florida, as well as Greenville AFB, Mississippi, and Nellis AFB, Las Vegas. He retired from the Air Force with the rank of full colonel. He currently (2016) lives in Soap Lake, Washington.

Captain George F. Heinrich, USAF

Born in Kalamazoo, Michigan (date unknown), George Heinrich graduated from the U.S. Naval Academy and was commissioned in the USAF in 1954. He completed pilot and navigator training before serving for five years as a crew member in the Strategic Air Command (SAC). He then took a master’s degree course in Nuclear Engineering at the Air Force Institute of Technology (AFIT), graduating in 1963. He served two years with the Solid State Physics Lab of the Aerospace Laboratories. In recognition for his piloting skills, Heinrich received the DFC and Air Medal with 9 Oak Leaf Clusters. He also earned a second (unidentified) master’s degree from George Washington University. In July 1966, upon graduation from the Air Command and Staff College, he served as an operations research analyst, Office of Research Analyses, Office of Aerospace Research, Holloman AFB, New Mexico. [12]

John W. Holtzclaw, USN

Little is known of John Holtzclaw’s early life (born July 4, 1934) and naval career. Available information centers on his involvement in a dramatic helicopter rescue on the night of June 18/19, 1968, when a flight of three aircraft from the aircraft carrier *USS America* (CV-66) were on a bombing mission over North Vietnam. Lt. Cmdrs. John ‘Claw’ Holtzclaw and John A. ‘Zeke’ Burns were in a McDonnell Douglas F-4J *Phantom II*. Shortly after midnight, several SA-2 surface-to-air missiles were fired at their aircraft. Holtzclaw and Burns evaded two, but a third missile detonated nearby, destroying the outer one-third of the right wing. With their airplane critically damaged and on fire, the two men were forced to eject over enemy territory, parachuting into a rice paddy. They could hear enemy soldiers talking nearby, and Burns had suffered a broken leg among his injuries. Aboard the guided missile frigate *USS Preble* (DLG-15), Lt. (junior grade) Clyde Lassen and his helicopter crew were awakened and assigned to rescue the downed crew, 70 miles away in total darkness. They took off from *Preble* aboard their SH-2A *Seasprite* helicopter and were vectored by radar to the location of the downed aircrew. Meanwhile, Holtzclaw and Burns could hear the enemy closing in. Lassen landed in a rice paddy about 60 yards away and a fierce firefight erupted between the North Vietnamese soldiers and the gunners of the Navy helicopter. Lassen held the *Seasprite* in a hover to prevent it from sinking into the mud, while the gunners jumped down to assist Holtzclaw and Burns aboard. As soon as they were loaded, Lassen took off and headed toward the South China Sea, 20 miles away. They were too far away to make it back to *Preble*, so they turned toward *USS Jouett* (DLG-29). Capt. Robert Hayes, commanding *Jouett*, turned his ship toward the shore and proceeded at full speed, turning on all the ship’s lights so that Lassen would be able to find it. With almost no fuel remaining, Lassen made a straight-in approach and landing. The helicopter crew of four was later awarded a Medal of Honor, Navy Cross and two Silver Stars for the daring mission. Holtzclaw would later serve as the commanding officer of VH-103. After leaving the U.S. Navy, he became an aviation lawyer, and still practices in Arlington, Virginia. [13]

Charles J. Howard, M.D.

In a richly varied life, Charles Howard was a pilot, an entrepreneur, businessman and physician. He was born on December 3, 1934, in Houston, Texas, the fourth child of Roy and Anna Smith Howard. Upon graduation from Austin High School in Houston, he attended the University of Colorado as a pre-med student. He was then accepted into Officer Candidate School with the USAF, where he graduated as a distinguished Aviation Cadet, Class 1957A, and was commissioned a second lieutenant. He attended Advanced Fighter Pilot School at Williams AFB from 1956-57 and later became a member of the Air Force's Thunderbirds, with the call sign '*Ace in the Hole*.' After completing his tour of military duty, he returned to Houston, where he married Cathryn Cauthron and entered the University of Houston to continue his pre-med studies. He received his Doctor of Medicine degree from the University of Texas Medical Branch at Galveston in 1963. He served as a medical officer for NASA in 1965 and, in 1966, was the flying training supervisor with the 147th Fighter Interceptor Group at Ellington AFB based in Houston. Later that year, he began his medical practice at Tidelands General Hospital. serving as the hospital's Chief of Staff until 1968. He then joined ten other physicians to develop the Houston Northwest Medical Center that opened in 1974, becoming Chief of Staff two years later. In 1983, he retired from active medical practice and moved to Beaver Creek, Colorado, where he served on the board of directors of the Vail Valley Medical Center until 2003. Among other involvements, he was a partner and owner of numerous businesses in the northwest Houston area, as well as a partner in Aspen Aviation in Colorado. Having enjoyed a love of all things aviation throughout his life, Howard died, aged 82, on October 15, 2006. [**14**]

Hugh M. Jackson

After graduate study at Cornell University, Hugh Jackson was employed at the Douglas Aircraft Company, and later at Hughes Aircraft Company. He returned to the University of Illinois for additional graduate work, as well as pilot training with the U.S. Air Force. Jackson received his bachelor of science degree (with honors) in Aeronautical Engineering from the University of Illinois. He began teaching engineering classes while still in school, and would complete his doctoral dissertation in 1969. Before that, in June 1966, he entered NASA's Flight Research Center (now the NASA Armstrong Flight Research Center) as a research pilot in the center's Flight Operations Department. Over the next five years, Jackson served as project pilot in the general aviation research program and Aero Commander Fluidic Autopilot research program; work previously done by former NASA astronaut Fred Haise prior to his departure after joining NASA's astronaut corps. Jackson also flew zero-g profiles in the F-4A *Phantom*, gathering biomedical research data on three instrumented animals – a cat, a rat, and a monkey – while positioned in the rear cockpit, to determine their physiological reactions to the environment. On July 25, 1967, during what would be his last flight in this particular F-4, stray voltage arced across the fuel sensor unit in the starboard wing tank as the landing gear retracted on take-off and the wing fuel cells pressurized. The resulting explosion ripped a large hole through the wing. Jackson landed safely on the dry lakebed and the badly damaged aircraft was subsequently retired from service. He also flew safety chase missions for flights of the X-15 rocket plane, the YF-12 *Blackbird*, and lifting body aircraft. He was involved in F-106 engine studies, Mars Viking recovery support, balloon drag research, and other NASA and USAF programs. While with NASA, in addition to the F-4, he flew F-104, F-5D, F-111, F-8, T-33, B-57, JetStar, Learjet, C-47, Aero Commander, and Twin Comanche aircraft. Upon leaving NASA in 1971, Jackson returned to the teaching profession and the military reserve. [**15**]

Thomas R. Kloves

Born April 10, 1932, in Louisiana to Engel and Louise Kloves, Thomas Kloves attended Rice University (Aviation), Houston, from 1951-1955, and was awarded his bachelor of science degree in Mechanical Engineering. He sailed on three cruises as a midshipman to Europe and the Caribbean, and served as navigator on *USS De Long* (DE-684) in 1954. In 1955, he made his first solo flight at Whitney Field, U.S. Naval Auxiliary Air Station, Milton, Florida. Cmdr. Kloves is believed to have been the first CO of VSF-86, serving circa 1970 – August 1971. He was employed at MSC, Houston in 1972, and attended the Management Development Program with M.P. Frank. [16] In 1974, he was serving as manager of NASA's Principal Investigation Management Office (PIMO) at Houston. By 1976, he was working as manager of the Program Planning Office, Space Shuttle Program at JSC. [17] He received the NASA Exceptional Service Medal in 1981. From 1981 to 1985, while employed at NASA's Johnson Space Center (JSC), he studied Management Systems in classes at the University of Houston, Clear Lake, and at the University of Colorado, Denver, receiving his master's degree in Business and Public Administration. He then served from October 1986 to June 1992 as Director, Business Development, for Grumman Aerospace, before taking a position as General Manager, Houston, for Dual Inc. He now owns TK&A, which provides consulting services to aerospace engineering firms.

Richard Allen Laidley, PhD (Geology)

Doctor Richard Allen ('Dick') Laidley, PhD, died in Tucson, Arizona, on December 21, 2015. He was 86 years old and the last survivor of his immediate relatives. Born November 26, 1929, he retired from the United States Air Force as a lieutenant colonel, and had served as an F-86 Jet Combat Fighter Pilot during the Korean War. He subsequently flew as a pilot in the Arizona ANG from 1957 to 1966, prior to moving to Houston, Texas, to work for NASA. Dr. Laidley had a varied career, which included earning a bachelor of science degree from the University of Illinois, and a PhD in Geology from the University of Arizona, becoming a NASA instructor in lunar geology to the Apollo astronauts. Later in his career, he became a NASA test pilot, serving as the Chief Flight Instructor for the JSC pilots and astronauts and Chief Test Pilot at JSC. He was also the initial chief of the Shuttle Chase Program at NASA's Dryden Flight Research Center, Edwards AFB, California. Over his career, he was the recipient of many honors and awards. His great, great, great grandfather, Lemual Graves of Massachusetts, served as a soldier in the Continental Army during the American revolutionary war. [18]

Lieutenant Richard L. Martin, USN

Born in Utica, Ohio, Richard Martin graduated from Granville High School in 1955, and from the U.S. Naval Academy four years later. In December 1961, he reported to VF-191 at NAS Miramar, California, where he flew the F8U-1 *Crusader*. In 1966, following his initial four-year tour as a fighter pilot, Capt. Martin attended the U.S. Naval Postgraduate School and underwent astronaut screening. Capt. Martin made three combat cruises to

Southeast Asia and has flown every operational model of the F8 *Crusader*. He was the 28th pilot to exceed 2,000 hours in the F8, in which he made 550 carrier landings. From March to July 1982, he served as the first commander of the nuclear carrier *USS Carl Vinson* (CVN-70).

Milton Matter, Jr.

Milton Matter served as a command pilot and flight surgeon. Born February 28, 1932, he attended Cranbrook preparatory school in Bloomfield Hills, Michigan (Class of '49) and later studied at Stanford and Purdue universities. In 1953, he joined the U.S. Air Force, training with Aviation Cadet Class 55-G. Following graduation from pilot training, he began flying jet fighters with the Indiana ANG. Matter graduated from Medical School in Bloomington in 1961, but opted not to transfer to the Medical Corps. He continued to fly, and was assigned for a time at the USAF Flight Test Center at Edwards AFB. He later worked for NASA on the Gemini program, and in 1986 was employed at NASA Ames Research Center, California. He spent a total of 30 years in the ANG and USAF Reserve, the last six as a brigadier general, including time as vice commander of the 10th Air Force. This allowed him to check out in the A-10 *Thunderbolt* (also known by aircrew as the 'Warthog'), and he also flew the F-80 *Shooting Star*, F-84F *Thunderstreak* and F-86 *Super Sabre*. He is a member of the F-86 Sabre Pilots Association. He later became interested in diving medicine and negotiated a contract with Ecuador's Ministry of Defense to search for sunken Spanish galleons.

He is known to have followed a medical career, and a Dr. Milton Matter Jr, MD is listed as having a surgery in Nashville, Indiana, now closed (though the authors are not sure if this is the same person). Now retired from medical practice, he currently resides in Berkeley, California.

Captain John J. Metzko, USMC

Born January 6, 1930, little is known of the early life of John Metzko. In May 1962, he was attending Princeton College's Department of Aeronautical Engineering and co-wrote the report '*Model Studies to Determine a Winged Gem Configuration for the Curtiss-Wright Air Car*' along with fellow USMC student and future NASA Group 5 astronaut, Gerald P. Carr. He served with VMA(AW)-531 and later VMA(AW)-225, which was deployed to Da Nang Air Base, Vietnam, to provide air support for allied ground elements of the I Corps area of South Vietnam by attacking surface targets. Lt. Col. Metzko was later assigned as CO of the squadron (January-June 1970), based at NAS Cherry Point, North Carolina. As head of the Air Weapons Systems Branch at U.S. Marine HQ, he was also involved in the evaluation and procurement of the British V/STOL *Harrier* aircraft. He now resides in Arlington, Virginia.

Captain Jack Franklin O'Hara, USN

Born April 11, 1930, Jack O'Hara commissioned from the Naval ROTC unit at the University of New Mexico. He subsequently applied for flight training at NAS Pensacola, Florida, receiving his aviator's wings in March 1954. Following a tour flying Grumman

S2F *Trackers*, he moved to light attack squadrons, serving in VA-83 ('Rampagers'), and later as XO and CO of VA-46 ('Clansmen'), flying the Douglas A-4 *Skyhawk* and the A-7 *Corsair*. His subsequent command assignments included Air Wing 11 at NAS Leemore, California, and he completed combat tours over two wars. During the Korean conflict, he served on board an LSD (Landing Ship, Dock), and later during the Vietnam conflict he served with VA-46 on *USS Forrestal* (CV-59) and with Air Wing 11 aboard *USS Kitty Hawk* (CV-63). He subsequently attended the Naval Postgraduate School and Princeton University, receiving a master's degree in Aeronautical Engineering. After his retirement in 1982, now with the rank of rear admiral, he attended law school and later practiced law in San Diego. He died on February 11, 1998, aged 67.

Captain Ernest Arthur Olds, USAF

Born July 14, 1934, in Salisbury, Maryland, Ernest Olds attended the U.S. Naval Academy from 1952-1956. Upon graduation, he was commissioned a second lieutenant in the USAF and undertook basic jet pilot training at Webb AFB, Big Spring, Texas, followed by advanced training at Moody AFB, Valdosta, Georgia. He was then assigned to the 4th Fighter Interceptor Squadron (FIS) at Misawa AFB, Japan, from 1961 to 1963. On his return, Olds enrolled at the University of Michigan, earning two master's degrees; one in Aeronautical and Astronautical Engineering and the other in Instrumentation Engineering. His next assignment was the 46th Test Wing at the USAF Missile Development Center, Holloman AFB, New Mexico, flying the C-131 *Samaritan*. Following his unsuccessful application for astronaut training with NASA, he transferred to Flight Test Division at Griffin AFB, Rome, New York. In 1967, he was reassigned to McDill AFB, Florida, where he received training in the F-4 *Phantom*. Soon after, in September 1967, he left for Da Nang AFB, Vietnam and the 12th TFW. He would later serve with the 480th TFS and 366th TFW. In March 1968, aged just 33, he was shot down over hostile territory and was listed as MIA, until May 2, 1978 when his status was changed to Killed in Action (KIA). His cremated remains were repatriated to the U.S. in 1996 and entombed at Arlington National Cemetery. He ended his career as a colonel in the USAF (promoted posthumously), having received the Purple Heart, DFC, National Defense Medal, and other medals and awards posthumously. [19]

Lieutenant Dwight Curtis Owings, USN

A native of Sylacauga, Alabama, Dwight Owings was born on January 20, 1932. He attended Alabama Polytechnic Institute, majoring in chemical engineering a year before entering the U.S. Naval Academy on a senatorial appointment, where he graduated with a bachelor of science degree in 1956. At USNA, Owings showed superior leadership potential, serving as 6th Battalion Operations Officer in his first class year. He entered flight training and received his naval aviator wings in 1957 and then joined Attack Squadron 93 at NAS Alameda, California, where he served until he reported to the Naval TPS at NAS Patuxent River, Maryland, in 1962. As a project pilot, he participated in testing the Navy's newest aircraft. After finishing his tour as a test pilot, he was assigned aboard the carrier *USS Franklin D. Roosevelt* (CV-42) as assistant navigator. In 1965, he was cited in *Naval Aviation News* for making the 142,000th carrier landing in a jet attack aircraft. He returned to flying attack aircraft and was attached to Attack Squadron 2 at NAS Oceana, Virginia Beach, and was training in the A-6A *Intruder* aircraft at the time of his death. Lt. Cdr. Owings died, aged 34, on September 27, 1966, when his A-6 jet exploded over Chesapeake Bay.

Lieutenant Robert V. Sallada, USN

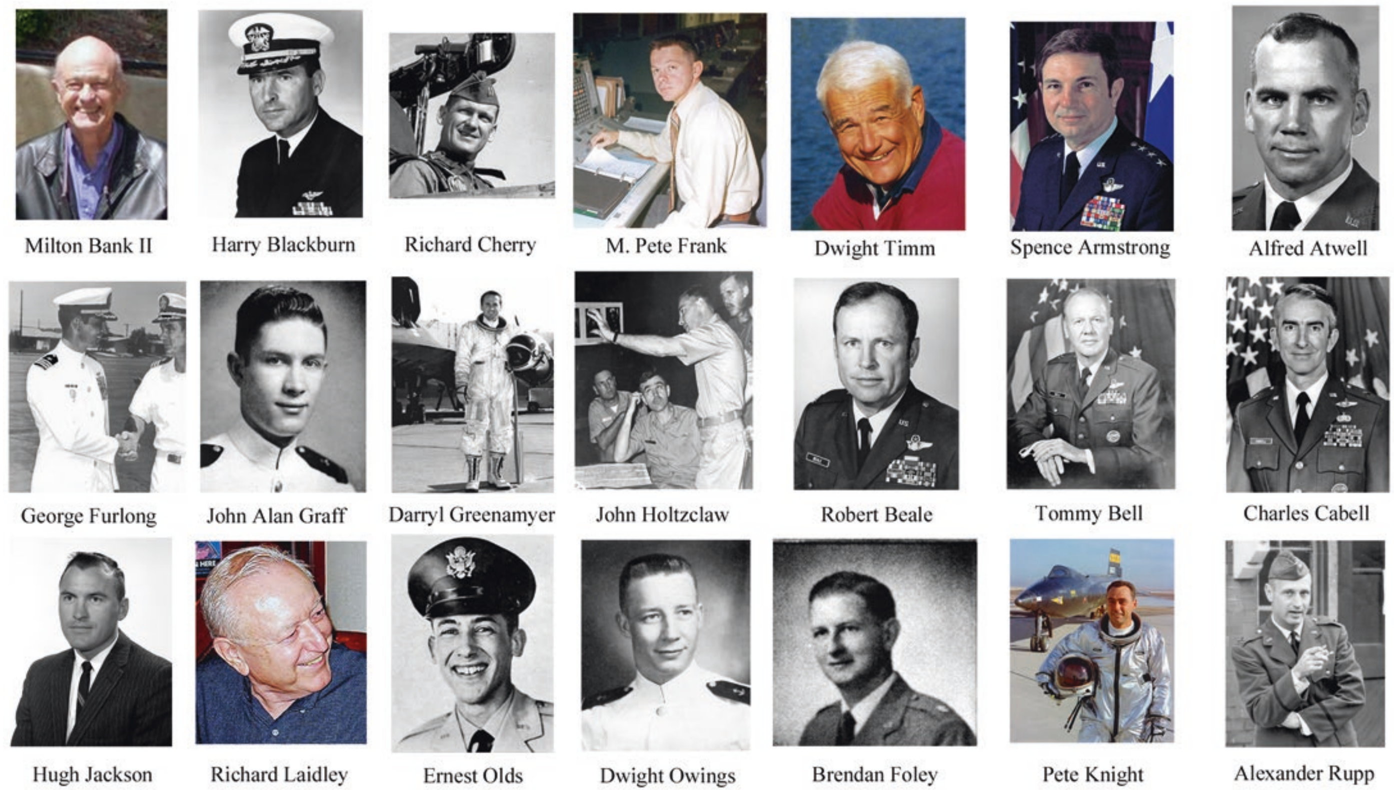
Robert (Bob) Sallada was born in Cincinnati, Ohio, on December 1, 1936. He attended the U.S. Naval Academy and later served aboard *USS Kitty Hawk* (CV-63), standing fighter alert in Key West for photo reconnaissance missions during the Cuban Missile Crisis. Subsequently, Sallada completed a tour in Southeast Asia with an A-7 Squadron, flying 100 combat missions. Lt. Cdr. Sallada became XO of VA-81 (the 'Sunliners') at NAS Cecil Field, Florida, in July 1974, becoming the squadron's twenty-first commanding officer on March 3, 1975, a position he held until March 3, 1976. Sallada also served with VA-174 (the 'Hellrazors') and attended the Naval TPS at Patuxent River, Maryland, where he later became the school's director. After leaving Patuxent River, he resigned his commission from the U.S. Navy. In 1987, he joined Lockheed as its Navy Advanced Tactical Fighter (NATF) Program Manager. Five decades after he was shortlisted for the NASA Group 5 selection, he lives in Gainesville, Virginia, and is still an avid aviator involved in flying gliders.

Norman P. Shyken

Apart from the fact that he was born on November 24, 1932 in Omaha, Nebraska, there is little information available on Norman Shyken. What is known is that he was employed as a senior design engineer for McDonnell Aircraft Corporation and was involved in the NASA Gemini program. Shyken died, aged 45, on July 3, 1978, in St. Louis, Missouri.

Lieutenant Dwight Dorwan Timm, USN

Dwight Timm was born on July 30, 1933 and raised in North Dakota. He attended the University of North Dakota, earning a bachelor of science degree in Aeronautical Engineering. Enlisting in the Navy in 1956, he became a naval aviator in 1958. Timm graduated from the Empire Test Pilots' School (ETPS) in England and spent two years as a test pilot. In 1971, he was XO of VF-96 ('Fighting Falcons') and then CO in late 1972. In 1971 and 1972, aided by his leadership, the squadron received the Adm. Joseph Clifton Award as the most outstanding fighter squadron in the U.S. Navy. Timm became the fourth commander of the *USS Tarawa* (LHA-1) between June 24, 1980 and February 26, 1982. After retiring from the Navy, he worked for McDonald Aircraft and then retired to the Northern Neck of Virginia. He died, aged 82, on February 26, 2016.



Twenty-one individuals who were shortlisted for NASA Group 5 and MOL selection, but who, for various reasons, were not selected.

AMERICA'S UNSUCCESSFUL SECRET ASTRONAUTS

Between October 1964 and February 1966, the USAF evaluated 39 officers for selection to the MOL program, one of whom, Capt. Gervasio Tonini, was shortlisted twice. From these selections, a total of 17 pilots were chosen across the three groups of 1965, 1966 and 1967. But who were the remaining 22 officers who were not selected? The authors have compiled brief profiles of each of those men who came very close to being selected as members of America's 'secret' astronaut program for MOL.

Spence M. ('Sam') Armstrong [MOL II/III]

Despite the disappointment of not being selected for MOL, Spence Armstrong (who preferred to be called Sam) had a distinguished, high-ranking career in the USAF. He was born in Colombia, Tennessee on March 13, 1934 and, following graduation from Mount Pleasant's Hay Long High School in 1951, spent a year at Vanderbilt University before entering the U.S. Naval Academy, from which he graduated with distinction in 1956, earning a bachelor of science degree in Engineering.

Armstrong completed flight training at Greenville AFB in Mississippi, earning his pilot's wings in 1957. Further instruction was received at the F-86 gunnery school at Williams AFB, Arizona, and at the F-100 gunnery school at Nellis AFB, Nevada. In April 1958, he was assigned to the 356th Tactical Fighter Squadron (TFS) at Myrtle Beach AFB in South Carolina, flying F-100s. [20] In 1961, he started attending the University of Michigan, working towards his master's degrees in Astronautical Engineering and Instrumentation Engineering. [21]

Following graduate school in 1963, he was assigned to Holloman AFB in New Mexico, where he served as a guidance and control engineer. Armstrong then attended the U.S. TPS at Edwards AFB, California, as part of the 13-strong Class 64C, whose members included future NASA astronauts Charles Duke, Stuart Roosa and Alfred Worden, as well as MOL and NASA astronaut Henry Hartsfield. After graduation from the TPS, Armstrong received a two-year flight test assignment, including serving as the Convair F-106 *Delta Dart* test project officer at Holloman AFB. His next role was to prepare for a combat tour in Southeast Asia, by completing Republic F-105 *Thunderchief* combat crew training at McConnell AFB, Kansas. As an F-105 pilot with the 34th Fighter Squadron, based at Korat Royal Thai Air Force Base, Thailand, he flew 100 combat missions. Returning to the United States in July 1968, Armstrong resumed flight test work as an instructor and later served as the deputy commandant at the Aerospace Research Pilot School (ARPS). [21]

In August 1971, Armstrong attended the Air War College at Maxwell AFB, Alabama and, following graduation in May 1972, completed a tour as the senior Air Force representative at the United States Army Infantry School at Fort Benning, Georgia. In 1973, he was assigned as the base commander of the 12th Flying Training Wing at Randolph AFB, Texas. In July 1974, he became the commanding officer of the 80th Flying Training Wing at Sheppard Air Force Base. Returning to academia, he completed senior management courses at Columbia University in New York City and then Harvard University in Cambridge, Massachusetts, from 1976 to 1978. Following his studies, he became director for program integration, USAF Headquarters, Washington, D.C., in April 1978. His next posting was also at USAF HQ in

Washington D.C., as the deputy director of Space Systems and Command, Control and Communications, before returning to Randolph AFB in 1980 as the Deputy Chief of Staff for technical training. Following this assignment, Armstrong was appointed Commander of the Air Force Military Training Center, Lakeland AFB, Texas. [21]

During the Iran–Iraq War, Armstrong was assigned in August 1983 as Chief of the joint United States Military Training Mission, whose task was "to train, advise, and assist the Saudi Arabian Army." After two years in this assignment, he was promoted to lieutenant general and served as Vice Commander of Military Airlift Command at Scott Air Force Base, Illinois. In July 1987, Armstrong was assigned as Vice Commander of Air Force Systems Command at Andrews Air Force Base in Maryland. [21] In April 1990, after 34 years of military service, he retired from the U.S. Air Force. [22]

Post-service, Armstrong became more involved with America's civilian space program when he joined President George H.W. Bush's Space Exploration Initiative as Director of Program Architecture for the Synthesis Group, tasked with developing a structure to return astronauts to the Moon and then on to Mars. In 1991, he became Associate Administrator with NASA's Human Resources and Education Office, and in 1998 was appointed Associate Administrator, Office of Aerospace and Space Transportation Technology, where he was responsible for directing NASA's research into global civil aviation, revolutionary technology leaps, and advanced space transportation. Two years later, he became Senior Advisor to the NASA Administrator. From February 2000, Armstrong spearheaded NASA's effort to create new links with universities, industry and other scientific and technical agencies. He retired from NASA on December 31, 2002, after 11 years of service to the space agency. During his career at NASA, Armstrong was awarded the Presidential Rank of Meritorious Executive, the NASA Outstanding Leadership Medal, and the NASA Exceptional Service Medal. [22] He was awarded an honorary Doctor of Law degree from the University of Akron in Ohio. [23]

Alfred Lemont ('Al') Atwell (MOL I)

Al Atwell was born on April 18, 1929, in North Garden, Virginia, and graduated from the University of Virginia in 1952 with a bachelor of science degree in Chemistry. Upon graduation, Atwell entered the USAF, rising in rank to colonel at the time of his retirement. On October 22, 1962, Capt. Atwell was nominated to attend the third class of the ARPS at Edwards AFB and was identified as a USAF astronaut designee. [24] After failing to be selected to the MOL program, Atwell continued his Air Force career, gaining a master's degree in Engineering Administration from Syracuse University in 1967 [25]. Married with three children, Al Atwell passed away, aged 83, on April 13, 2013, just five days prior to his 84th birthday.

Robert S. Beale (MOL I)

Robert Beale was born on January 24, 1934, in Norfolk, Virginia. He was commissioned a second lieutenant through the USAF ROTC program on June 7, 1955, beginning active duty on November 15, 1955. Beale completed undergraduate pilot training and was awarded his pilot wings at Greenville AFB, Mississippi, in February 1957. After completing F-86 *Sabre* combat crew training, he was assigned to the 45th Fighter Day Squadron at Sibi Slimane AB, Morocco, where he served from September 1957 to February 1958. He then transferred to the 77th Fighter Bomber Squadron at RAF Wethersfield, England, where he served until September 1960. Beale then completed an AFIT assignment in October 1962 and served as a weapons systems engineer until he was selected to attend TPS at Edwards AFB, California, in June 1963. After completing TPS, he served as a flight test pilot at Eglin AFB, Florida, from August 1964 to August 1966. He then attended Air Command and Staff College from August 1966 to November 1967, and was assigned to the 44th TFS as an F-105 *Wild Weasel* pilot at Korat Royal Thai AFB, Thailand, from November 1967 until September 1968. During this period, Maj. Beale was awarded the Air Force Cross "for extraordinary heroism in connection with military operations against an opposing armed force, as an F-105 *Thunderchief* pilot on a missile suppression mission on an isolated vital military target near Hanoi, North Vietnam, on 16 December 1967."

Later promoted to the rank of colonel, Beale served with HQ USAF in the Pentagon from September 1968 to August 1971, followed by Air War College from August 1971 to June 1972. After graduating, he served as a Flight Test Officer at Edwards AFB from June 1972 to January 1974. Col. Beale next served as Vice Commander and then Commander of the 24th Composite Group at Howard AFB, Panama, from January 1974 to August 1975. He served with the 4th Tactical Fighter Wing (TFW) at Seymour Johnson AFB, North Carolina, from August 1975 to June 1978. His final assignment was as director of Armament and Avionics Requirements on the Staff at Headquarters Tactical Air Command at Langley AFB, Virginia, from June 1978 until his retirement from the Air Force on June 30, 1979. In addition to his Air Force Cross, he also received a Silver Star medal and the DFC for his service in Vietnam, as well as two awards of the Legion of Merit for his peacetime exceptional service. [26]

Tommy I. Bell (MOL I)

The McDonnell Douglas F-4C *Phantom II*, a long-range supersonic jet interceptor fighter-bomber, gave invaluable service during the Vietnam War at the hands of many superbly talented pilots. One of those was Capt. (later B/Gen.) Tommy Bell. In the space of just ten months, he flew 257 combat missions in the F-4C with calmness and tenacity.

Tommy Bell was born in Jacksonville, Texas on December 4, 1930. Sadly, both his parents died at a comparatively young age; he was only 13 years old when he lost his father. Taking his high school education at the School of the Ozarks in Hollister, Missouri, he graduated in 1948 and began a degree course in aeronautical engineering at the University of Illinois. In March 1952, he enlisted in the U.S. Air Force as an aviation cadet. He received his pilot wings and commission as a second lieutenant in March 1953 at Laredo AFB, Texas. Over the next four years, he served as a fighter pilot with the 71st FIS, then based at the Greater Pittsburgh Airport, Pennsylvania, and from August 1955 at Selfridge Field, Michigan, flying the F-86D *Sabre Interceptor*. Around this time, he met his future wife, Lillian Villiger. They would eventually have three children.

In June 1957, Lt. Bell was assigned to the AFIT at Wright-Patterson AFB, Ohio, later returning to the University of Illinois to complete his degree in Aeronautical Engineering. Immediately following his graduation, in May 1959, he was selected to attend the USAF Experimental Test Pilot School at the Air Force Flight Test Center, Edwards AFB, California. Two of his fellow students in Class 59C were Air Force Capts. James McDivitt and Edward White II, later selected as NASA Group 2 astronauts and who flew together on the history-making flight of Gemini IV. After graduating on April 22, 1960, Capt.

Bell was ordered to Wright-Patterson AFB, first as an experimental test pilot and later as chief of the Aero-Mechanical Branch of flight test engineering.

He would return to the TPS in May 1963, as an instructor in the Aircraft Stability and Control Division, specializing in the control of aircraft spins. It was during this time that Bell applied to NASA and became one of 34 finalists vying for selection to their second astronaut group, unfortunately without success. He then resumed his test work at Edwards AFB.

In 1966, Bell graduated from the University of Southern California, Los Angeles, with his master of science degree in Mechanical Engineering. In June that year, he was sent to McDill AFB, Florida, for combat crew training in the F-4. After volunteering for active duty in the Republic of Vietnam, Bell was assigned to Cam Ranh Bay Air Base. Here, the 12th TFW would be engaged in air-to-ground missions, including close air support and interdiction, as well as air-to-air missions such as rescue protection and combat air patrols. It was from this base that Bell flew his 257 combat missions in the F-4C from November 1966 to September 1967. During the latter half of this combat tour, he served as Operations Officer for the 391st TFS.

Bell's next assignment came in October 1967, when he was ordered to Headquarters, U.S. Air Force, for ground duties in the Directorate of Development and Acquisition. In 1972, he graduated from the George Washington University in Washington, D.C. with a master of science degree in Management, and that same year also graduated from the Industrial College of the Armed Forces in Washington, D.C. He was then assigned to the Aeronautical Systems Division at Wright-Patterson AFB, serving for two years as System Program Director for the F-4/RF-4 *Phantom* aircraft. In August 1974, he was reassigned within the Aeronautical Systems Division as Commander of the 4950th Test Wing, which operated and maintained numerous test bed aircraft. He would remain with the Wing until June 1977, before transferring once again to USAF Headquarters, for assignment as assistant director, Tactical Systems Test and Evaluation, in the Office of the Director of Defense Research and Engineering. He was promoted to the rank of brigadier general on August 1, 1977, with date of rank listed as July 17, 1977. Three months later, he became special assistant for the General Dynamics F-16 *Fighting Falcon*. In October 1979, he was assigned the position of Director of Development and Production in the Office of the Deputy Chief of Staff, Research, Development and Acquisition, also at USAF Headquarters.

B/Gen. Bell retired from the U.S. Air Force on September 1, 1980, and then went to work for Northrop Grumman on a top-secret development program, from which evolved the B-2 *Spirit* stealth bomber. He died at 80 years of age from a pulmonary embolism, at the Providence Little Company of Mary Medical Center in Torrance, California, on February 14, 2011. His many decorations and awards included the Legion of Merit, DFC, Bronze Star Medal, Meritorious Service Medal, Air Medal with 14 Oak Leaf Clusters and NASA's Distinguished Service Medal. [11]

Charles Pearre Cabell, Jr. (MOL II/III)

Charles Pearre Cabell, Jr. was born in San Antonio, Texas, on July 13, 1936, and graduated from Gonzaga High School, Washington, D.C., in 1953. He received a bachelor's degree in Engineering from the U.S. Military Academy at West Point, and was commissioned a second lieutenant in the U.S. Air Force in 1958. He earned a master's degree in Astronautics from the AFIT at Wright-Patterson Air Force Base, Ohio, in 1967 and a master's degree in Systems Management from the University of Southern California, Los Angeles, in 1971.

In August 1958, General Cabell entered flight training, receiving his pilot wings at Vance AFB, Oklahoma, in October 1959. He was then assigned to Chennault AFB, Louisiana, where he flew B-47s. From August 1960 to June 1965, he served at Loring AFB, Maine, as a B-52 pilot. After completing the AFIT program in June 1967, Cabell went to the Republic of Vietnam, where he initially served as an aircraft commander in the F-4 *Phantom* at Cam Ranh Bay Air Base, and then as a Forward Air Controller and Air Liaison Officer flying the 0-1 *Bird Dog* in the III Corps area, ending up with more than 500 combat flying hours. Upon returning to the United States in May 1969, he was assigned to the Satellite Test Center in Sunnyvale, California, as director of the field test force for several satellite programs. He earned his master's degree in Systems Management during this assignment. Cabell graduated from the Air War College at Maxwell AFB, Alabama, in June 1974, and was selected to serve as military assistant to the director of land warfare for the Directorate of Defense Research and Engineering in the Office of the Secretary of Defense, Washington, D.C. In 1976, he became military assistant to the Chief Scientist of the Air Force, Headquarters U.S. Air Force, Washington, D.C.

From May 1978 to May 1981, General Cabell was assigned to the Electronic Systems Division at Hanscom Air Force Base, Massachusetts, where he held several key positions, including Deputy Director for the Base and Installations Security Systems Program, Director for the Iranian Air Defense Program, Director for the Combat Information Systems Directorate and Assistant Deputy for Communications and Information Systems. He then transferred to Wright-Patterson AFB, Ohio, as Deputy for Reconnaissance, Strike and Electronic Warfare Systems with Aeronautical Systems Division, and in September 1982 was named Commander of the Aeronautical Systems Division's Air Force Wright Aeronautical Laboratories. In March 1983, General Cabell returned to Hanscom AFB as the Deputy for Airborne Warning and Control Systems, Headquarters Electronic Systems Division, Air Force Systems Command, and was promoted to brigadier general on August 1, 1983. He subsequently assumed duties as Commandant, Defense Systems Management College, Fort Belvoir, Virginia in September 1985.

He retired from the U.S. Air Force on May 1, 1988 and then spent nine years as a consultant to industry and government in the areas of system engineering, risk management and project management. He retired from this occupation in 1997 to become a writer, and is also a gifted pianist. B/Gen. Cabell is a command pilot with 3,500 flying hours. His military decorations and awards include the Legion of Merit with two Oak Leaf Clusters, DFC, Bronze Star Medal, Meritorious Service Medal with Oak Leaf Cluster and Air Medal with 17 Oak Leaf Clusters. He became the third member of his family to attain general officer status. His late father, Gen. Charles P. Cabell, retired from the U.S. Air Force in 1962. At that time, he was the Deputy Director of the Central Intelligence Agency. His great-grandfather was a brigade commander for the Confederacy until captured in 1863 by Union forces. [27]

Thomas J. Davey, Jr. (MOL II/III)

Only limited information is available on Capt. Thomas Davey Jr. It is known that he was a member of the 14-strong student test pilot Class 65C of the U.S. Air Force TPS (Edwards AFB, California). This class consisted of 10 Air Force pilots, one Navy, one Marine, as well as two Allied student pilots (one from Germany, one from Italy) who would graduate and depart the school after nine months having completed the Experimental Phase. Future MOL/NASA astronaut Robert Overmyer was a USAF member of Davey's 65C class. In July 1968, it is recorded that Davey served three times as a Lockheed F-104 *Starfighter* chase pilot supporting the X-15 program.

John W. Dettmer (MOL II/III)

John William Dettmer was born in Cincinnati, Ohio, on September 21, 1935. He took his early education at Purcell High School, and is a graduate of the University of Cincinnati. Affiliated with the Phi Kappa Theta fraternity, American Institute of Electrical Engineers, Pershing Rifles and Eta Kappa Nu, Dettmer is known to have been based at Davis-Monthan AFB, Arizona, in 1961, with the 15th FIS, part of Air Defense Command. The squadron was newly equipped with McDonnell F-101B *Voodoo* supersonic interceptor aircraft, and the F-101F operational and combat-capable conversion trainer. [28]. He became a student test pilot with the ARPS as part of Class 66B, but is said to have left before the class graduated. He was a graduate of the AFIT, Air University, Wright-Patterson AFB, Dayton, Ohio. Col. Dettmer is known to have been working in the aeronautical laboratories at Wright-Patterson in 1980, and currently lives in Albuquerque, New Mexico.

Alan L. Devereaux (MOL II/III)

Col. Alan Leigh Devereaux was born in Wooster, Ohio, on December 1, 1932. Little is known of his early life, except that he graduated from the West Point Academy in 1954 and holds a master's degree in Business Administration from the University of Chicago. He was a member of the Class 65B student test pilots at the TPS at Edwards AFB, California, graduating in 1966.

In 1974, Col. Devereaux became the new Test Forces Director at Edwards AFB. For the previous 20 months, he had headed the Airborne Warning and Control System (AWACS) Joint Test Force, overseeing operation of all seven of the center's (then) top test programs. In addition to AWACS, these included the advanced medium STOL (short takeoff and landing) transport, the B-l supersonic bomber, A-10 close support aircraft, YF-16 and YF-17 lightweight fighter, F-15 air superiority fighter and F-5 *Tiger H* fighter. As Test Forces Director, he oversaw flight test engineering activities, providing many technical services vital to the center's weapon systems development test and evaluation mission. He has also served as Director of Operations and Vice Commander of the U.S. Air Force's Arnold Engineering Development Center in Tennessee. In 1978, he was listed as the Air Force's Deputy for Operations, Space and Missiles Systems Organization in Los Angeles, California. [29]

After leaving the Air Force with 6,000 hours of logged flight time as a command pilot and navigator, Devereaux joined Pan American World Services, then became a director of the contractor executive development program for the Eastern Test Range in Florida. In January 1983, he began teaching courses in aviation math, management and air operations, as a Professor Emeritus in the Aeronautics faculty at the Florida Institute of Technology [30]. Today, he and his wife live in Jacksonville, Florida.

Brendan ('Bren') Patrick Foley (MOL II/III)

Brendan Foley was born in Ireland on March 27, 1932. In 1947, when he was 15 years old, his family emigrated to the United States and settled in New York City. Little is known of his early life, but it is recorded that he met his future wife Betty Ahern on a blind date in 1952, when he was an ROTC student at New York University and she was attending the College of New Rochelle. When they married in 1956 following her graduation, he had already gone into pilot training. He entered active service with the U.S. Air Force in 1957 and was accompanied by his wife through tours of duty in Europe, California, Troy, New York, and Wright-Patterson AFB in Dayton.

When Foley received his orders for South East Asia, he first attended F-4 Phantom Combat Crew Training School at Shaw AFB, South Carolina. His Southeast Asian tour began on July 23, 1967, as a member of the 11th Tactical Reconnaissance Squadron, based at Udorn Airfield, Thailand. On November 24, 1967, Maj. Foley and 1st. Lt. Ronald M. Mayercik crewed an RF4C *Phantom* jet sent on a photo reconnaissance mission over the Plaine des Jarres (Plain of Jars) in Northern Laos. Foley was the pilot, while Mayercik manned the camera and technical equipment for the mission. Their aircraft was flying alone. At 01:25 hours, shortly after take-off, the last radar contact was made with Foley and Mayercik's *Phantom*. At that time, it was passing over extremely rugged mountains covered in dense jungle, less than a mile west of Route 4, the primary north/south road in the region, paralleling the Nam Huong River that was located just to the east of Route 4. The point of last contact was approximately 25 miles north of the Laotian/Thai border, 45 miles southeast of the Plaine des Jarres, 50 miles southeast of Long Tieng, Laos and 60 miles northeast of Udorn Airfield, Thailand. Since it was not unusual for aircraft to be lost from radar contact while flying over the rugged mountains of Laos, no concern was raised until the *Phantom* failed to return to base as scheduled. A search and rescue operation began at first light. During the search, no emergency radio beepers were heard and no wreckage was sighted. [31]

At the time the formal search effort was terminated, Brendan Foley and Ronald Mayercik were reported as MIA. Their remains have not been recovered; however, the co-pilot's dog tags were found. Brendan Foley was promoted to the rank of colonel and Ronald Mayercik to the rank of captain during the period they were maintained MIA. They would remain in that status until the Secretary of the Air Force approved Presumptive Findings of Death for them: Col. Brendan P. Foley, New York, NY (10/09/1980) and Capt. Ronald M. Mayercik, Edison, NJ (07/28/1977). [32]

Patrick Henry, Jr. (MOL I)

Lt. Patrick Henry Jr., was known to have been a member of Class 63A of the ARPS at Edwards AFB, California. While attending ARPS, 28-year-old Lt. Henry Jr., U.S. Navy, AFSC, AFFTC, then residing in Triangle, Virginia, was scheduled to fly two zoom-climb maneuvers in the stubby-winged Lockheed F-104A *Starfighter* (56-0764), as part of the curriculum, on June 15, 1964. Class 63A was scheduled to graduate the following month. His first zoom-climb at 08:30 was routine and he landed in a normal manner after reaching a peak altitude of 78,600 feet (23,957 m). The second zoom-climb, at 10:20, was routine in all respects up to the peak of the zoom. The radar plot showed Henry's initial climb angle at 45 degrees, gradually increasing to 52 degrees near the peak of the maneuver at 83,000 feet (25,298 m). As the nose of the F-104 fell through the peak of the zoom, the aircraft yawed to the left at around 135 degrees. The nose almost leveled, then yawed right, and the aircraft entered a flat spin. Lt. Henry attempted spin recovery, with the aircraft rotating at one revolution every six seconds. He also attempted several air-starts of the engines as he passed through 65,000 feet (19,812 m), but was unsuccessful. At 35,000 feet (10,058 m), he selected take-off flaps with no effect. Spinning through 25,000 feet (7,620 m) the drag chute was deployed, also with negligible effect. Henry ejected successfully at 4,000 feet (1,219 m) and was immediately rescued uninjured by helicopter. Still in a flat spin, the aircraft impacted the ground and exploded three miles north of Rogers Dry Lake. [33]

James F. Humphries, Jr. (MOL II/III)

James Humphries, Jr., a native of Colombia, South Carolina, was born on November 13, 1934. In 1952, he graduated from Dreher High School and later received his bachelor's degree in Mechanical Engineering from Clemson University in South Carolina. While there, he was commissioned through the U.S. Air Force's ROTC. He would later be awarded two master's degrees from the University of Michigan.

There is a mention of a James F. Humphries serving as a B-57 pilot at Robins AFB in 1956, but the authors are not sure if this is the same man. During the Vietnam War, Lt. Col. Humphries flew 101 combat missions on Lockheed AC-130 *Spectre* gunships and the B-57G *Canberra* as a tactical bomber pilot, and won a DFC "for aerial achievement in Southeast Asia."

Humphries graduated from Class 66A of the ARPS at Edwards AFB, California in 1967, and afterwards remained on their staff of instructors. At that time, he had logged over 4,000 hours flying time in bomber aircraft, transports and helicopters. He later took employment as an aeronautical engineer and instructor with the Warner Robbins Air Materiel Area. He then became a staff development officer at the USAF HQ Aeronautical Test Division. By 2002, three generations of his family were serving in the USAF; his son, Lt. Col. Thomas D. Humphries, USAF was an HH-60G Special Operations/Combat Rescue helicopter instructor pilot at Kirtland AFB, New Mexico, and his grandson, Timothy J. Humphries, was a cadet colonel on an Air Force ROTC scholarship at the University of Arizona.

Wendell R. Hull (MOL II/III)

Wendell Ray Hull was born on April 21, 1933, in Trinity, Lewis County, Kentucky, the son of (Willie) Frank and Mary Elizabeth Boyd Hull. While little is known of his early education, he graduated from the University of Kentucky with a bachelor of science degree in Mechanical Engineering, earning a regular commission in the U.S. Air Force as a distinguished graduate. He became a member of the Arnold Air Society (a national society of AFROTC cadets who excel in character and academics, and exhibit interest in the study of aerospace technology) and Tau Beta Pi. He entered active duty in the U.S. Air Force in 1956.

Capt. Hull was selected to attend Class 64C of the USAF ARPS. Several MOL and NASA astronauts were in this group of student test pilots: Stuart Roosa, Charlie Duke, Hank Hartsfield and Al Worden. Upon graduation, he was designated a fighter test pilot and flew every fighter-type airplane in the U.S. inventory up to and including the F-4 *Phantom*. In December 1966, he was promoted to the rank of major while serving at the Air Proving Ground Center at Eglin AFB, Florida. Later, with the rank of lieutenant colonel, he attended the AFIT and earned a master's degree in Aerospace Engineering.

During his 26-year USAF career, he was a tactical fighter pilot, an experimental test pilot, and an aerospace development engineer. He was stationed at multiple bases in the United States and deployed to several foreign countries. Hull invented, developed and flight tested the guidance mechanism for the laser guided bomb system. Later, when stationed at Ubon, Thailand, he became the first person to drop a smart bomb in combat while testing the system in Vietnam. He then completed a full combat tour of duty, flying 100 missions in the F-100 *Super Sabre* while stationed at Tuy Hoa, Republic of South Vietnam.

Subsequently stationed at Wright-Patterson AFB in Dayton, Ohio, he managed the development of the Ford Aerospace AN/AVQ-26 Pave Tack Forward Looking Infrared (FLIR) targeting system in the late 1970s, a pod equipped with a laser to guide smart bombs at night or in zero visibility. [34]

Col. Hull's last Air Force tour of duty was as commander of the 6595th Shuttle Test Group, where he oversaw the construction, development and testing of the USAF Space and Missile Test program (deactivated in 1979). During his distinguished military career, he was awarded the Legion of Merit, the DFC, the Meritorious Service Medal (twice), eight Air Medals, the Air Force Commendation Medal, the Combat Readiness Medal, and numerous other decorations, including the Republic of Vietnam Gallantry Cross with device.

Following his retirement from the U.S. Air Force in 1982, he began an 11-year career at Rockwell International Missile Systems Division in Duluth, Georgia, where he was a manager of research and development. Col. Wendell Hull passed away, aged 81, at his home in Norcross, Georgia, on February 18, 2015, following a lengthy illness. His wife Sue (née Calvert) also sadly passed away in December that same year.

Jimmy D. Kempton (MOL II/III)

Although only limited details are available, it is known that Jimmy Kempton was born March 1, 1938, and is a native of Twin Falls, Idaho, a University of Idaho graduate, and a decorated fighter pilot who served two tours of duty in Vietnam. As a first lieutenant, he was a member of the 481st TFS of the 27th TFW, based at Tan Son Nhut in the Republic of Vietnam. The squadron was operating North American OV-10 *Bronco* light attack and observation aircraft and the F-100D *Super Sabre* out of Da Nang in 1965 (Kempton's F-100D was named 'Lickety Split'). In 1972, on his second combat tour of Vietnam, he flew F-4 *Phantom* supersonic fighter-bombers behind North Vietnamese lines with the U.S. Air Force's 390th TFS, known as the 'Da Nang Gunfighters.' For one particular action, he was awarded the DFC.

The DFC citation reads: "The President of the United States takes great pleasure in presenting the Distinguished Flying Cross to Major Jimmy D. Kempton for heroism while participating in aerial flight as Aircraft Commander near Quang Tri, Republic of Vietnam, on April 4, 1972. On that date, Major Kempton's flight of F-4s was scrambled in support of a Search and Rescue operation being conducted for three American pilots downed by North Vietnamese surface-to-air missiles. It was only through outstanding airmanship that this last of the SAR ordnance was delivered on target before nightfall, in spite of the extremely poor weather, hazardous terrain and intense hostile ground fire. Major Kempton's selfless and heroic performance was instrumental in the safe recovery of two of the aircrew members. The outstanding heroism and selfless devotion to duty displayed by Major Kempton reflect great credit upon himself and the United States Air Force." [35]

Lt. Col. Kempton retired from the U.S. Air Force and later became an assistant professor of physics at the Air Force Academy, as well as a Pentagon liaison between the Secretary of Commerce and the Secretary of Defense. He then became a six-term member of the Idaho House of Representatives. On February 23, 2012, Idaho Governor C.L. Otter announced the appointment of Jim Kempton of Albion, a former legislator and Idaho Public Utilities Commission member, as a member of the Idaho Transportation Board. [36] He and his wife Susan live in Albion, Idaho. They have two grown daughters.

William J. ('Pete') Knight (MOL I)

An exceptionally talented test pilot who holds the world's speed record for winged powered aircraft, William Knight (better known as 'Pete') was born on November 18, 1929, in Noblesville, Indiana. After high school, he attended Butler and Purdue Universities, entered the Air Force Aviation Cadet Program in 1952, and was commissioned in 1953. While still only a second lieutenant, he flew a Northrop F-89 *Scorpion* at the September 1954 Dayton Air Show, winning the Allison Jet Trophy.

By 1958, Lt. Knight had graduated from the AFIT at Wright-Patterson AFB, Ohio, with a bachelor of science degree in Aeronautical Engineering, and went straight into Class 58C at the USAF TPS at Edwards AFB, California. Two members of his class would go on to become NASA astronauts: Ed Givens, Jr., and Tom Stafford. Following the class graduation on April 24, 1959, Knight remained at Edwards, serving as a test pilot. In this capacity, he flew in the F-100 *Super Sabre*, F-101 *Voodoo*, F-104 *Starfighter*, and later T-38 *Talon* and F-5 *Tiger* test programs. He wanted to become involved in the X-20 Dyna Soar program, even though he had also been following the progress of the X-15 research program, later stating that he was more interested in Dyna Soar at that time. There were six USAF pilots assigned to the X-20 program in 1960, and they worked hand-in-hand with the Boeing Corporation in developing the cockpit, subsystems, procedures and profiles that would be used to demonstrate and test the X-20. They would spend over 400 hours in the X-20 simulator. Then, Defense Secretary Robert S. McNamara unexpectedly cancelled the Dyna Soar program in December 1963.

Keenly disappointed at the cancellation of the program, Knight returned to Edwards AFB to complete the second half of the ARPS as a member of Class 63A. He had previously completed the first, test pilot portion, of the course and this second half was devoted to preparations for space flight. His class graduated in mid-1964, and while he thought of applying to NASA as an astronaut, he decided instead to opt for the X-15 program, for which he was selected.

Altogether, he would complete 16 flights in the X-15, during which he became one of only five pilots to earn their astronaut wings by flying an airplane in space, having reached an altitude of 280,500 feet (see Table 3). On October 3, 1967, a B-52A *Stratofortress* carried X-15A-2, piloted by Maj. Knight, to an altitude of 43,000 feet, where the winged spacecraft was released. He accelerated the aircraft to the world speed record of Mach 6.72, or 4,534 miles per hour – a record that still stands today.

Following 10 years at Edwards, Knight was assigned combat duty in Southeast Asia, where he flew the F-100 *Super Sabre* on a total of 253 missions. On his return, he was assigned to Wright-Patterson AFB as Test Director for the F-15 *Eagle*. He later became Program Director for the International Fighter (F-5) Program at Wright-Patterson. In 1979, he returned to Edwards AFB, where he served as a test pilot for the F-16 *Fighting Falcon*.

In 1982, having given 32 years of service during which he logged over 6,000 hours in more than 100 different aircraft types, he retired from the U.S. Air Force, now bearing the rank of colonel.

In 1984, Knight was elected to the city council of Palmdale, California, first as a councilman and then winning election as the city's first mayor four years later. In 1992, he was elected to the California State Assembly, and then served in the California State Senate from 1996 until his death on May 7, 2004 in Duarte, Los Angeles. [**37**]

Eldred D. ('Don') Merkl (MOL II/III)

When astronauts Jim McDivitt and Ed White splashed down in their Gemini IV spacecraft on June 7, 1965, Capt. (Eldred) Donald Merkl, USAF, born in Lincoln, Alabama in January 1936, decided he wanted to become an astronaut. The son of Eldred T. and Katie (Hollingworth) Merkl, he married the former Anne Henley of Talladega, Alabama, right out of high school. They both attended Auburn University for two years until Dirk, their first son, was born. At Auburn, Merkl was awarded his bachelor's degree in Electrical Engineering in 1957, and through their ROTC program, received his commission as a second lieutenant in the U.S. Air Force. After receiving his Air Force wings, he served as an instructor pilot at Laredo AFB, Texas, flying both T-33 and T-37 jet trainer aircraft.

Merkl came to Texas Tech University as a graduate student in electrical engineering from Laredo AFB in May, 1962, under the AFIT program, which allowed qualified applicants to work toward graduate and undergraduate degrees while still drawing full Air Force pay and allowances. He was a pace-setter of sorts at Texas Tech, being the second PhD candidate in electrical engineering and the first to complete all course work with a straight-A average.

Prior to receiving his doctorate and master's degree in Electrical Engineering from Texas Tech in 1964, Merkl said, "I would like to be assigned to first-line aircraft after I leave Tech. My choice would be with the Air Force Systems Command as a test pilot." He expressed a preference for assignment to Edwards AFB (California), Eglin AFB (Florida) or Kirkland AFB (New Mexico). In November that year, he also made his first, unsuccessful, application to become a NASA astronaut [**38**].

In 1966, with some 2,000 hours of flying time logged, Merkl was then assigned to Class 66B at the ARPS at Edwards AFB, California, later graduating first in his class. Major Merkl then began attending the U.S. Air Force Air Command and Staff College at Maxwell

Table 3 X-15 Free Flights Flown by Pete Knight 1965-1968

Knight's Free Flight	Date of Free Flight	Program Free Flight	X-15 Flown	Free Flight Time (min:sec)	Max Speed (mph/kph)	Mach	Max Altitude (feet/meters)	Knight's X-15 records
1	1965 Sep 30	151	#1	08:22.6	2,718 / 4,374	4.06	76,600 / 23,348	1st X-15 free flight
2	1965 Oct 12	152	#3	07:07.8	3,108 / 5,002	4.62	94,400 / 28,773	1st #3 flight
3	1966 Jul 12	160	#1	08:38.5	3,652 / 5,877	5.34	130,000 / 39,624	
4	1966 Jul 21	162	#2	08:51.0	3,568 / 5,742	5.12	192,300 / 58,613	1st #2 flight
5	1966 Aug 3	164	#2	09:10.7	3,440 / 5,536	5.03	249,000 / 75,895	
6	1966 Aug 12	167	#2	08:36.6	3,472 / 5,588	5.02	231,100 / 70,439	
7	1966 Aug 30	170	#2	08:57.9	3,543 / 5,702	5.21	100,200 / 30,541	
8	1966 Nov 18	175	#2	08:26.8	4,250 / 6,840	6.33	98,900 / 30,145	
9	1967 May 8	180	#2	08:26.6	3,193 / 5,139	4.75	97,600 / 29,749	
10	1967 Jun 29	184*	#1	10:07.0	2,870 / 4,619	4.17	173,000 / 52,730	
11	1967 Aug 21	186	#2	07:39.3	3,368 / 5,420	4.94	91,000 / 27,737	
12	1967 Oct 3	188	#2	08:12.1	4,520 / 7,274	6.70	102,100 / 31,120	Fastest speed; highest Mach
13	1967 Oct17	190	#3	10:06.4	3,869 / 6,227	5.53	280,500 / 85,496	Highest altitude; 1st Astro-flight
14	1968 Apr 26	194	#1	09:17.1	3,545 / 5,705	5.05	209,600 / 63,886	
15	1968 Jul 16	196	#1	09:42.6	3,382 / 5,443	4.79	221,500 / 67,513	
16	1968 Sep 16	198	#1	10:55.5	3,723 / 5,992	5.37	254,100 / 77,450	Penultimate X-15 flight

[*] Indicates an in-flight abort
Data courtesy, *North American X-15, Owners Workshop Manual*, David Baker, Haynes Publishing, 2016

AFB, Alabama, in a curriculum covering advanced military leadership, management, and use of aerospace forces.

Having written a dissertation on the flight control system of the multi-role General Dynamics F-16 *Fighting Falcon*, Merkl taught control theory at the Air Force Academy and the USAF TPS at Edwards AFB. He would later assist with the adaptation of the F-16 flight control system for the Lockheed F-117A *Nighthawk* stealth attack aircraft. [39] From December 1979 to August 1981, he became the Air Force's first Senior Trend Program Manager for the USAF Systems Command Aeronautical System Division at Wright-Patterson AFB, Dayton, Ohio. Following this duty, he retired from the Air Force. He now lives in Newman, Georgia.

Gerald T. Morris (MOL II/III)

Capt. Gerald Morris did not attend USAF TPS. No further details have been located.

Leslie J. Pruitt (MOL II/III)

Born August 6, 1932, Leslie Pruitt graduated from the U.S. Military Academy (Class of '55), West Point, in 1955. He served with the 340th Bombardment Squadron (Heavy) between 1959-1962, flying B-52 *Stratofortress* aircraft, and was later attached to the 97th Bomber Wing from 1962 to 1964. Pruitt attended the ARPS at Edwards AFB, California, from 1964 to 1965, before taking up two years of test pilot duties at Wright-Patterson AFB, Ohio. Assigned to the Southeast Asian War in 1967, he flew with the 45th Tactical Reconnaissance Squadron based at Tan Son Nhut, near Saigon, flying combat missions in the F-101 *Voodoo* supersonic jet fighter. This squadron was involved in most major operations of the Vietnam War. He flew more than 255 combat missions and was awarded two DFCs and 13 Air Medals. From 1971-1972, he served with Headquarters, Pacific Air Force, before being assigned to 4900 test group at Kirtland AFB, New Mexico. Lt. Col. Pruitt retired from the USAF in 1976 after serving for 22 years. In his second career, he worked for Allstate Insurance, and now resides in Albuquerque, New Mexico.

Alexander Kraz Rupp (MOL I)

Alex Rupp came into the world on July 2, 1930, in the Centre County Hospital in historic Bellefonte, a Victorian-style town nestled in the Nittany Valley of Centre County, Pennsylvania. He took his education at Central High School in Washington and not only shone academically, but rose to become captain of the cadet corps in his senior year. Upon graduation, the Navy awarded him a Holloway scholarship for study at Harvard University. After two years, he had some doubts that the system would ever lead him any higher than lieutenant commander, so he left college and took a job running a bulldozer and later, a gasoline-powered shovel.

It would only ever be an interim measure, as Rupp began attending National Guard drills at summer camp. His dedication and perseverance paid off, finding his name high on the 1951 list, and he was appointed to West Point from the National Guard. He entered West Point with the Class of 1955 (A-2 Company) on July 3, 1951. Fortunately, Rupp found the academic side of life at West Point relatively easy and his experiences with the Navy, at college, and on the construction job would also continue to serve him well. He became a cadet sergeant and company supply sergeant during his first class year.

Rupp would eventually graduate 63rd in his West Point class, on June 7, 1955, and had already decided on a career in the U.S. Air Force. After commissioning, and during his regular flight training in Texas and at Greenville AFB, Mississippi, he also worked on airplane and automobile engines in his spare time at the local base shops.

He was one of the first in his class to be assigned to a fighter squadron (36th Fighter Day Wing) in Germany, and was stationed near Bitburg over the next four years. Here, he not only became fluent in German, but met and married a German girl named Ruth Michaels. They would have two children.

The Air Force Academy proposed sending Rupp to school at the University of Mayence [Mainz] with a view to him teaching German at the Air Force Academy, but he aspired to a space career. He succeeded in drawing a stateside assignment at Wright-Patterson AFB and there earned a master's degree in Astronautics from the AFIT in 1962. From there, he went to Edwards AFB in California, for duty in the ARPS program.

On March 30, 1963, Capt. Rupp was one of 14 Air Force captains chosen to participate in the ARPS at Edwards. The ARPS IV class of which Rupp was a member began their studies on 17 June. At about the same time, he sent in his application to NASA, who had announced they were seeking a third group of astronauts for the Gemini and Apollo programs. His ARPS class consisted of 16 test pilots, many of whom would later try out – some successfully – for selection by NASA as an astronaut. In addition to the 14 USAF pilots, there was one USN representative and one from the USMC. At the end of the intensive seven-month course, the graduates knew they would be available for assignment as a pilot, manager, or consultant in any future U.S. manned spaceflight programs. The class would graduate on 20 December 1963, by which time he had heard that he had failed to make the third astronaut group.

From Edwards, Rupp returned to Wright-Patterson AFB, where he worked with the test mission program of the Aeronautical Systems Division. On June 11, 1965, he was operating an F-102A jet interceptor on a routine test flight out of Wright-Patterson, and was airborne at 11:04 a.m. Once over the test area, he engaged the adaptive autopilot and performed the first of his planned instrument check maneuvers. He then rolled into the first dive-and-pull-out test while reporting his reactions to Flight Test back at Wright-Patterson. His second dive was conducted at a lower altitude, and once again he pulled back up hard without incident. At 11:27 a.m., having reported on the success of the tests to that time, Maj. Rupp started into his third dive.

Immediately after the aircraft had passed over Camp Canaan it suddenly exploded, tearing the aircraft apart in the skies over Highland County. Wreckage of the F-102A was scattered over two cornfields near Ohio state highway 134, 50 miles south of Wright-Patterson.

Following an extensive investigation, the primary cause of the loss of the pilot and aircraft given in the July 29, 1965 Accident/Incident Report was "material failure due to fatigue in the Number 5 spar, resulting in structural breaking of the left wing. Fire and explosion contributed to complete disintegration." It was further noted that the wing in question had been reclaimed from a "previously-wrecked aircraft." Maj. Alex Rupp was buried in Arlington National Cemetery. He was 34. [11]

Gary T. Smith (MOL II/III)

Born in Klamath Falls, Oregon, on May 10, 1931, Gary Smith was a 1949 graduate of Klamath Union High School. He attended the U.S. Naval Academy, Annapolis, graduated in 1954 and then transferred to the U.S. Air Force, completing a service tour in Southeast Asia during which he flew F-4 *Phantom* jets on combat missions over Vietnam. He received the DFC and Air Medal with 12 Oak Leaf Clusters and the Air Force Commendation Medal. He was then stationed for two years at Eglin AFB, Florida. Smith was reported to have been killed during an F-4 test flight at Eglin on May 27, 1970, aged 39. There is no record of him attending the USAF TPS.

James R. Stanley (MOL II/III)

Capt. James R. Stanley was a student test pilot in Class 63A at the USAF TPS, Edwards AFB, California. While serving as an F-4 *Phantom* fighter-bomber pilot with the 497th Tactical Fighter Squadron during the Vietnam War, he was awarded the DFC "for extraordinary achievement while participating in (undated) aerial flight while serving with the 497th Tactical Fighter Squadron [the 'Night Owls'] in Southeast Asia." He was further awarded a Bronze Oak Leaf Cluster "in lieu of a second award of the Distinguished Flying Cross for extraordinary achievement while participating in aerial flight while serving with the 497th Tactical Fighter Squadron in Southeast Asia on 10 August 1967." No further biographical details are known.

Gervasio ('Jerry') Tonini (MOL II/III)

Born in Butler, Pennsylvania on June 18, 1934, Jerry Tonini attended Butler Senior High School until 1952, following which he studied at the University of Pittsburgh until 1956, graduating with a bachelor of science degree in Mechanical Engineering. He received his Air Force pilot wings in 1957, followed by fighter gunnery training in the F-86 *Sabre*. Although his choice was fighter aircraft, he was assigned as a B-47 *Stratojet* pilot, flying worldwide missions for the SAC. One of his early experiences involved learning how to do a half loop and then a half roll in a B-47, as one of the maneuvers to escape a nuclear blast after dropping an atom bomb.

While serving at Schilling AFB, Kansas, he applied for and was accepted into the ARPS at Edwards AFB, California. He had been in the Air Force for seven years, and had been based at Schilling for four years as a B-47 aircraft commander with the 379th bomb squadron of the 310th aerospace wing. He was one of 10 USAF captains selected for the 19-person course, and one of only two pilots from the SAC.

Following his graduation from the ARPS, Tonini served two, four-year tours at Edwards AFB as a test pilot, separated by a one-year tour in Vietnam as an Airlift Operations Officer and C-130 Pilot. On his return from Vietnam in the fall of 1968, he served in the Test Operations Division at Edwards. At the completion of his second Edwards AFB tour, he was selected to attend Graduate School, receiving his MBA at San Diego State University in 1973. Upon graduation, he was assigned to the Air Force Logistics Command (AFLC) at McClellan AFB, Sacramento, California, as the F100/F105 Systems Engineer.

A chance meeting with a colonel visiting McClellan, who recognized his development experience at Edwards, resulted in his reassignment to the AX Program, (later known as the A-10A *Thunderbolt* II, but affectionately call the ‘Warthog’). He established a cadre of personnel to usher in the A-10A program at McClellan. After a couple of years, he was selected to replace the colonel as the Deputy Program Manager for Logistics (DPML) at Wright-Patterson AFB, Ohio. He served in that capacity until his retirement from the Air Force in 1978.

Tonini was then hired by The Boeing Company as an engineer and logistics specialist, initially working for the Director of Product Support. As his first major task, he completed a study entitled BRASS (Boeing Rapid Ammunition Supply Study), looking at the ammunition resupply for the U.S. Army’s prototype General Support Rocket System (GSRS). After completion of the study, he was assigned to the MX Missile Program as the lead maintainability engineer for the transporter that would be used to move a missile between several horizontal shelters, dubbed the ‘Nut Shell Game.’ However, the MX Missile Program was reorganized when Ronald Reagan became president and became silo based, thus eliminating his position as the MX transporter engineer.

He subsequently served as a technical representative for the Boeing T-43A Navigator Training Program (16 Boeing 737s) and later became the Boeing Base Manager for the T-43 Navigator Training Program. After six years at Mather AFB, Sacramento, California, he was then selected as the E-4B (Doomsday Aircraft) Program Manager for The Boeing Company at Oklahoma City. After three years, he moved to Boeing in Seattle, where he worked for a short time on the Patrol Hydrofoil Missile (PHM) Ship Program, then two years on the F-22 fighter program, and finally in a small commercial derivatives group attempting to sell Boeing aircraft to the USAF; such as the B-747 to supplement the USAF’s C-17 Program, and the B-767 aircraft to replace the KC-135 USAF tanker aircraft.

After 18 years at Boeing, he retired in August 1995. He then moved to the Olympic Peninsula, where he instructed pilot students and flew charter flights for Right Bros. Aviation at Port Angeles, Washington. He is currently fully retired and living in Sequim, Washington, but keeps his aviation interest alive as a member of the EAA Chapter 430 (Experimental Aircraft Association) and the QBs (Quiet Birdmen). He was the *only* applicant to be considered for both MOL Group 1 and Group 2/3. [40]

Joseph P. Waters (MOL II/III)

Joseph Patrick Waters, who served with the U.S. Air Force in both Korea and Vietnam, was born on March 31, 1932. Capt. Waters was a member of the ARPS Class 66B. On October 16, 1972, Waters was flying an Air Force F-4C (upgraded to an YF-4E configuration) *Phantom* fighter jet with Capt. John Evans as his engineer. They were operating as a chase plane during a test mission of another aircraft over the desert, about 10 miles north of Edwards AFB, when, at 4:30 p.m., there was a flight control malfunction accompanied by a pitch-up, and a crash ensued. The Air Force later identified the men as Capt. John D. Evans, 32 years old, of Farmington, Iowa, and Lt. Col. Joseph P. Waters, 40, from New York City. [41] Joseph Waters was interred at Arlington National Cemetery, Virginia.

OTHER POSSIBLE APPLICANTS

Over the years, several other names have been linked, both to the NASA Group 5 selection and the USAF MOL selections. But their progress in these selections is unclear. They have been listed here for completeness pending any further information.

Frederick Rodgers Dent, III

Born at Kelly Field, San Antonio, Texas, on April 3, 1934, Fred Dent was the son of Maj. Gen. Frederick Rodgers Dent, Jr. and Corra Lynn Dent, both deceased. As an Air Force child, he spent his early years at Wright-Patterson AFB in Ohio before enrolling at Phillips Academy in Andover, Massachusetts. He was accepted at the U.S. Military Academy, West Point, in 1952 and, on graduation, was commissioned as a second lieutenant in the U.S. Air Force in 1956. He took undergraduate pilot training at Marana Air Base, Arizona, and Webb AFB, Texas, and in 1958 undertook advanced gunnery training at Luke AFB, Arizona.

Fred Dent, who was not shortlisted, one of several pilots who have been linked to the Group 5 selection.

His first assignment, from 1958-1961, was flying F-100Ds at Kadena AFB in Japan, in the 16th TFS, 18th TFW. He then returned to the University of Texas, graduating with his master of science degree in Aerospace Engineering in 1963. He was then assigned to Eglin AFB Air Proving Ground in Florida, developing and testing weapon systems. In 1965, Dent was chosen to attend the ARPS at Edwards AFB and remained at the school from 1965-1968 as an academic and flight instructor. While there, he was the project pilot on the rocket-powered NF-104 aircraft and NF-106 variable stability trainer. In 1969, he became a flight commander and assistant Ops officer in the 308th TFS, based at Tuy Hoa in the Republic of Vietnam. While there, he completed over 350 combat hours.

After returning from Vietnam, Dent attended the Air Command and Staff College at Maxwell AFB. His next assignment was to the Pentagon, to develop flight programs for the YF-16 and YF-17 prototype test programs. In 1974, he became a charter member of the Air Force Test and Evaluation Center (AFTEC), where he managed the F-16 Initial Operational Test & Evaluation program (IOT&E) at Kirtland AFB, New Mexico. His final assignment, from 1977-1980, was as Director of the Avionics Division at Eglin AFB, after which he retired from the U.S. Air Force.

Col. Dent would eventually log more than 3,587 flight hours in 36 different aircraft. He was awarded the DFC, Meritorious Service Medal with Oak Leaf Cluster, Air Medal with 12 Oak Leaf Clusters and the Air Force Commendation Medal. Following his Air Force career, Dent established a waterfront oyster bar and continued to work in the defense industry in Shalimar, Florida, and with General Dynamics as an IOT&E program manager in Taiwan. He returned to his beloved Poquito Bayou in Florida to continue work as an instructor for Embry Riddle Aeronautical University. Col. Frederick Rodgers Dent III, U.S. Air Force (Ret.), died, aged 79, on January 1, 2014. [42]

Stanley P. Lewis

Col. Stanley P. Lewis graduated from Stanford University, California, in June 1954, and was commissioned a second lieutenant in the U.S. Marine Corps through their ROTC program. He completed basic school at Quantico, Virginia, and entered naval flight training at Pensacola, Florida, receiving his Wings of Gold as a naval aviator in May 1956. His assignments took him to Hawaii with Marine Attack Squadron VMA-214 (the famed 'Blacksheep' squadron) and U.S. Marine Corps Air School in Beaufort, South Carolina. He earned a master's degree at the Naval Postgraduate School in Monterey, California, and served at NAS Atsugi in Japan. Maj. Lewis later attended another air school in El Toro, California, and graduated with Class 66B of the ARPS at Edwards AFB, California.

After promotion to lieutenant colonel, he then served with VMA(AW)-242 of the 1st Marine Aircraft Wing, based at Da Nang Air Base, Republic of Vietnam. He participated in combat operations against the Viet Cong and the North Vietnamese Army, operating on many *Operation Rolling Thunder* missions (deep strikes) over North Vietnam.

After various tours and air wing commands, and graduation from the Naval War College in 1975, he was eventually named as manager in the V/STOL Harrier Program Office. He directed development of the YAV-8B *Harrier* II prototype by McDonnell Douglas and began the engineering development phase of the AV-8B, used by the Marines in Iraq. Col. Lewis retired from the Marine Corps in 1980 and was an executive and program director with Rockwell and Boeing until 1998. He has flown 37 different aircraft types and accumulated 4,200 military flight hours.

SUMMARY

These, then, were the 47 officers who were shortlisted for the NASA (25) and USAF MOL (22) astronaut programs, but did not make the final selections. In addition, we have identified three others who have been linked to the selections as potential applicants. Though these men were not selected, nor flew in space, their participation and background are as important to the wider story as those who were fortunate to be known as 'astronauts.'

As fascinating as it is to follow the lives and careers of those who were selected from whatever country for space training, it is equally challenging to try to piece together those who were shortlisted for the final selection, but were passed over. It must have been a bitter-sweet feeling to have been nominated to go as far as the final selection, only to receive a call thanking them for their commitment and application, but stating that they would not be called upon to progress further.

In each of the books in this series, in which the authors have tried to record each astronaut group chosen between 1959 and 1969, we have endeavored to find out as much as we could about those who were shortlisted, but not selected. This is an ongoing project, and if any reader has information on those listed above in this chapter, the authors would be most grateful for any information to update their files, and fill in more of the story.

References

1. Frank Ellis: "No Man Walks Alone," *Foundation* magazine, Spring 1996
2. David Martin: "He Fights for a Chance to Fly," *Life* magazine, issue October 25, 1963
3. Emery Cowan: "Profile: Frank Ellis," University of Colorado magazine archive, Boulder, CO. 2016
4. *Call for Valor Military Times*, Frank K. Ellis, Distinguished Flying Cross, "All Hands," January 1964
5. Eloise Engle: "He Fights for the Right to Serve his Country," *Listen* magazine, Vol. 17, No. 5, September/October 1964
6. Jack Ferrell, email to Colin Burgess, June 23, 2016
7. William Anderson: "Navy Amputee's Aim is to be an Astronaut," *Chicago Tribune* newspaper, June 28, 1964
8. Frank Ellis: telephone conversation with Colin Burgess, June 29, 2016, and letter confirming all details correct dated July 29, 2016
9. *The Monterey Herald*, June 9, 2010
10. The Virtual Wall, Vietnam Veterans Memorial, www.virtualwall.org entry for Captain Harry Lee Blackburn Jr., also TogetherWeServe.com, last accessed July 24, 2016
11. ***Moon Bound: Choosing and Preparing NASA's Lunar Astronauts***, Colin Burgess, Springer-Praxis Books, Chichester, U.K., 2013
12. Information from 1968 sources
13. Naval Aviation through the Decades: War in Vietnam, Part 8, By Robert F. Dorr, August 26, 2011, www.defensemedianetwork.com
14. Obituary, Charles J. Howard, Sr. Online at http://www.legacy.com/obituaries/houstonchronicle/obituary.aspx?n=charles-j-howard&pid=19617447
15. NASA Former Pilots: Hugh M. Jackson, Online at: https://www.nasa.gov/centers/armstrong/news/Biographies/Pilots/bd-dfrc-2-10.html
16. JSC Roundup Volume 10 No 25 October 22, 1971, p.1.
17. Space Shuttle Program: An Overview, Thomas R. Kloves, NASA JSC, Houston, Texas. Paper 76-275 AIAA/CASI 6th Communications Satellite Systems conference, April 5-8, 1976, Montreal, Canada
18. *Arizona Daily Star*, February 21, 2016
19. www.VirtualWall.org, entry for Ernest A. Olds, last accessed July 24, 2016

20. USAF Biography, "Lieutenant General Spence M. Armstrong, United States Air Force," September 1987
21. Doc Mirelson and Brian Dunbar for NASA: "Spence M. Armstrong to Retire From NASA," November 27, 2002
22. Rich Cooper and Scott Glasser for NASA: "Senior Adviser to the Administrator; Lieutenant General Spence (Sam) Armstrong, USAF (Ret.)," August 5, 2002
23. See Ref. 20; also, NASA Office of the Senior Advisor to the Administrator, biography of Sam Armstrong, dated August 15, 2002
24. *Washington Post* October 23, 1962
25. *America's Forgotten Astronauts*, David J. Shayler & Philip W. Snowdon, *Spaceflight,* Volume 23 No. 1 January 1981, pp. 3-12
26. Veteran Tributes: Robert S. Beale. Online at: http://veterantributes.org/TributeDetail.php?recordID=429
27. U.S. Air Force Biography, "Brigadier General Charles P. Cabell, Jr." at http://www.af.mil/AboutUs/Biographies/Display/tabid/225/Article/107184/brigadier-general-charles-p-cabell-jr.aspx
28. *Tucson Daily Citizen* (Arizona), newspaper article, "Ross-Dettmer Betrothal," issue September 9, 1961, pg. 30
29. *The Bakersfield Californian* newspaper article, "Col. Flood leads test engineering activity at Kern Air Base," issue October 11, 1974, pg. 27
30. Campus Notes, Florida Institute of Technology, issue January 1983.
31. *Find a Grave* website, "Col. Brendan Patrick 'Bren' Foley," extracts taken from tributes given by family and friends. Online at: http://www.findagrave.com/cgi-bin/fg.cgi?page=gr&GRid=60744974
32. POW Network, *Brendan P. Foley*. Online at: www.pownetwork.org/bios/f/f023.htm
33. ARPS F-104A (56-0764) Return Visit blog message by "xplaneguy," January 14, 2010, available online at: http://pacaeropress.websitetoolbox.com/post?id=4302942. Last accessed September 22, 2016
34. Mary Anne Kearns: "Col. Hull," *The Ledger Independent* (Maysville, Kentucky), newspaper, issue March 30, 2015. Online at: http://www.maysville-online.com/news/local/obituaries/col-hull/article_34d2dc1f-93c6-51ad-8e6a-309784158042.html
35. Liberty 1st organization, Honor Roll. Online at: http://www.liberty1st.org/honorroll/citation_detail.asp?ID=6149. Last accessed September 1, 2016
36. Idaho Governor C. L. Otter News release, February 23, 2012
37. ***The X-15 Rocket Plane: Flying the First Wings into Space***, Michelle Evans, University of Nebraska Press, Lincoln, NE, 2013
38. *The Texas Techsan* magazine, article, "To the Moon," Vol. XVI, No. 1, August 1965
39. ***Have Blue and the F-117A: Evolution of the Stealth Fighter***, David Aronstein and Albert Piccirillo, published by the American Institute of Aeronautics and Astronautics, 1997
40. *The Salina Journal*, Salina, Kansas, newspaper article, "10 Airmen Looking for Space," issue October 11, 1963, pg. 12. Other biographical information based on Jerry Tonini's Facebook pages https://www.facebook.com/gervasio.tonini1
41. *New York Times* newspaper, article, "2 Die in F-4 Crash," issue October 18, 1972
42. Obituary, Frederick Rodgers Dent III, available online at: http://www.legacy.com/obituaries/nwfdailynews/obituary.aspx?pid=168975738? Last accessed June 5, 2016

4

Preparing for Apollo

"The training is endless
It takes all your days,
But then comes the flight
And you find it all pays."
'Training' Alfred M. Worden,
from Hello Earth: Greetings from Endeavour, 1974.
(Used with permission)

As NASA's latest astronauts began arriving in Houston, the focus at the Manned Spacecraft Center (MSC), in nearby Clear Lake, was on completing the current two-man Gemini program, with over a third of the scheduled ten manned missions still to fly. Although the fifth group of astronauts had been chosen to crew missions beyond the Gemini program, the '19' would monitor the final Gemini missions and the early flights of the Apollo program, as part of a year of academic, general and scientific training, to help prepare them for their first crew assignments.

Meanwhile, the first group of Manned Orbiting Laboratory (MOL) pilots, detailed to the USAF Space Systems Program Office in California, had already completed several weeks of preparation to fly the classified 'Blue Gemini' missions. The MOL training syllabus was markedly different to that of the civilian NASA program, focusing primarily on the space laboratory with its clusters of highly classified experiments and equally covert objectives, together with studies of the systems of the Gemini spacecraft that pairs of astronauts would ride in to orbit, and in which they were to return at the end of their planned 30-day missions.

Although the objectives of both programs were poles apart, there remained many similarities between the military and civilian programs, with crew survival a key factor in training *any* crew for a mission into space. This is a factor that has remained constant since those days, with only a few amendments as the technology and systems have evolved. For both groups, a series of academic and practical field training exercises were provided for them to learn how to cope with problems during launch, on orbit and during recovery. For both groups, there were challenges to master before taking their place on any flight crew,

D.J. Shayler, C. Burgess, *The Last of NASA's Original Pilot Astronauts*,
Springer Praxis Books, DOI 10.1007/978-3-319-51014-9_4

including learning new skills which were not normally part of pilot training. Unlike the MOL astronauts, where the crucial focus was on mastering the techniques associated with detailed Earth observations, the NASA astronauts began a series of geology training sessions, an essential tool for assignment to Apollo landing crews. However, even in these early months, some of the astronauts would also begin Earth observation training, with a view to possible assignment to an orbital workshop crew under the Apollo Applications Program (AAP). Their focus was directed towards the atmosphere, Earth resources and environmental fields, rather than the ground surveillance and military objectives for which the MOL pilots were training.

As the MOL pilots familiarized themselves with the (modified) Gemini spacecraft they would fly, which NASA was beginning to phase out, the Astronaut Office at Houston was looking ahead, training crews to operate the more sophisticated and adaptable Apollo spacecraft. By 1966 there were three types, or Blocks, of Apollo spacecraft being considered for diverse missions. From early 1967, the first two manned flights of the series, known officially as Apollo-Saturn (AS) -204 (but more commonly 'Apollo 1') and AS-205 ('Apollo 2'), would use the Block I spacecraft and the Saturn 1B launch vehicle. This version of the spacecraft did not feature any of the rendezvous and docking equipment which would be essential for the later lunar missions. These first proving flights were intended solely for man-rating the basic Apollo Command and Service Modules (CSM) for up to two weeks in Earth orbit and were slated to begin in early 1967, before sending subsequent Apollo missions out into deep space.

Later in the year, if all went well on the Block I missions, the improved Block II CSM would be introduced on the third manned mission. This flight would feature the necessary rendezvous and docking equipment and could support a two-week journey to the Moon and back. For 'Apollo 3' a dual launch was planned, with three astronauts launched atop a Saturn 1B (AS-207) to rendezvous and dock with a Lunar Module (LM) launched unmanned on another Saturn (AS-208). All operations would be restricted to Earth orbit, but would include the all-important first manned solo test flight of the LM. Following this, mission plans were in hand to fly several increasingly demanding missions, with every flight building upon the success (or learning from the failures) of the preceding missions. These objectives included man-rating the massive Saturn V, flying the CSM and LM in deep space and eventually on lunar orbital missions, and qualifying the pressure suit being developed for lunar surface operations on practice spacewalks in Earth orbit. All of this was aimed at the first attempts to land NASA astronauts on the Moon and return them safely home, at least once, by the end of 1969.

Finally, there was the third generation of the Apollo CSM, designated Block III. Once the initial lunar landings had been achieved, this spacecraft would be introduced under AAP to support more advanced lunar missions, as well as extended duration flights to orbital workshops created from spent Saturn upper stages.

For NASA's newest cadre of astronauts, there was a lot to learn and take in, and precious little time in which to accomplish this. Coupled with this was the prospect of a long and extremely demanding training program, as well as the logistics of moving their families to Houston and settling them in to a new life in Texas. They would also be trying to understand the workings of NASA and the unaccustomed publicity their new role would bring to them and, to an extent, their families.

INTEGRATING INTO THE NASA FAMILY

As soon as the Group 5 NASA astronauts had been publicly named, they were officially deemed 'astronauts', even though their training had yet to start. It would be another 12 years before the next group of new astronauts were chosen, specifically for the Space Shuttle program, at which time NASA coined the term 'astronaut candidate' or 'Ascan' instead of immediately identifying them as fully-fledged 'astronauts.' Since 1978, each successive group of Ascans has been required to complete a demanding 12- to 24-month period – depending upon the size of the intake – of general and 'wilderness' (the new word for 'survival') training before being officially termed 'astronauts.' But in the 1960s, that title was automatically awarded from day one at NASA, together with a silver 'astronaut' lapel pin. The single gold pin would be awarded, at an official Astronaut Office 'pin party,' only after completing a first space flight. In the Soviet Union, on the other hand, the belief was that you could not really be termed a 'cosmonaut' without having flown at least one orbit of the Earth. Until then, you were still 'in training.' For the '19,' that first flight was, of course, still some years in the future, and for a few of them, there would be a very long wait of some fifteen to nineteen years after selection.

Getting there

Having progressed through to the medical tests at Brooks and interviews in Houston, each applicant remained hopeful of being selected, but none could be certain. One by one, each of the 19 candidates was advised in early April 1966 that they had been successful. They also found out that they had to report to NASA MSC, Houston, Texas, by early May. For some of the serving military officers, this would be quite straightforward, almost like another military posting, but for others it became more complicated. For each of the seventeen married candidates, it would also involve relocation outside of the normal armed forces arrangements – almost, but not quite, back into a civilian environment – including moving house, setting up a new home for what could be several years, settling children into new schools and learning to endure the unforgiving humidity of southern Texas.

For their first few years at NASA, each candidate's time was heavily focused on learning their new trade and supporting the effort to reach the Moon. This may seem a long time, but there was only ever a single suitable launch window each month, of a few days, to ensure the most suitable lighting conditions at the intended landing site on the Moon, as well as launch and splashdown in daylight. This meant that only 43 such windows remained before the decade was out to reach the Moon. From day one, the pressure was on these men to deliver on the credentials for which they had been selected and to adapt into the NASA fold to get the job done. Guiding the family's adjustment to the new environment of Houston, especially in the humid summer of 1966 and for several years afterwards, would fall heavily on the shoulders of each astronaut's wife.

Most people relate the home of NASA's astronauts to the city of Houston in southern Texas. In fact, the sprawling campus-like Space Center is some 30 miles to the south, off the main Interstate 45S (South) that originates in Dallas, through downtown Houston and out towards the old community of Galveston on the Gulf Coast. Taking a left off the 'Gulf Freeway' section of I45S into the Clear Lake area today, the sprawling metropolis of

'Houston' extends well beyond the Space Center, but in the mid-1960s it was still a developing area, with new houses being built for those working in the rapidly expanding MSC. For most of the newcomers, it was a case of renting motel rooms near the Interstate, as there was little else around. Al Worden recalled in his 2011 memoir that, "on that 30-mile drive from Houston to NASA, I saw nothing but countryside, with fields full of oil wells. One of the roads that crossed my path went north to Clear Lake City where it dead-ended. Along the way were a few businesses and restaurants, but no homes. Straight ahead were the Space Center, three hotels, a grocery store and a couple of fast food places. That was all. If you make that journey today, it's wall-to-wall congestion all the way, with strip malls and cheap restaurants. But in 1966, NASA was in the middle of nowhere … except [for] some isolated ranchers and shrimpers." [**1**] Though time was spent going 'downtown' to Houston, the residential communities of Nassau Bay, Dickenson, El Lago, Kemah and Seabrook soon began to develop as the space program evolved, hugging the shoreline bayous and lakes on the main road called NASA Road One.

One of the first challenges for each candidate was actually to get themselves to Houston. While the rest of the family packed up ready for the move to Texas, some of the astronauts flew to their new assignment, while others drove. For Bill Pogue, the journey involved packing his belongings in his 1965 Volkswagen and heading southeast from Edwards Air Force Base (AFB) to MSC. His wife and children remained at Edwards until the end of the school year. Then, during the school holidays, Pogue flew back to California to help pack and organize the move, although he found that his wife had everything well in hand, all boxed up and labeled. The children were to stay at his wife's parents while they returned to Houston to set up their new home, joining them shortly before the start of the new school year. [**2**]

Jim Irwin's journey involved a drive down from Colorado Springs in his Karmann Ghia to Bachelor Officer Quarters (BOQ) at Ellington AFB. In those days, as he recalled some years later, those quarters were, "Old wooden barracks, not quite as bad as Hondo, but worse than Reese [both air bases in Texas]. I had a very small living room, a bedroom and a bathroom – and a refrigerator." Fortunately for Irwin, after checking out in the T-33 aircraft and building up hours in the T-38 in the few weeks he had been at NASA, he found he could fly himself to Colorado Springs to be with his family for the weekend. Irwin rented a very small apartment for the family close to MSC until September, when their house in Colorado was finally rented out. The drive down to Houston in a camper van was an ordeal for the family, as the closer they got to Houston the hotter it became. The other shock came when they saw the compact size of the duplex he had rented for them to live in, which he later described as "about as wide as a motel room. There were three bedrooms upstairs; living room, dining room and small efficiency-type kitchen were downstairs. I thought it was great – no yard responsibilities." [**3**]

Jerry Carr's journey to Houston proved to be a drive he would not forget. During the rainy season, and despite the risk of flash flooding in the desert, he had decided to take his prized 1953 MG TD sports car from California to Houston. Meanwhile his family, consisting of his wife JoAnn and six children, would follow once school finished for the summer break in June. It was to be a four-day drive for Jerry, beginning on April 28 and arriving at Ellington AFB in the early hours of May 2 after a 1,583-mile journey. Along the way, he stopped over in quarters at NAS Yuma, and woke the next morning to find he was covered in a red rash, diagnosed as 'three-day measles.' This meant he now had to travel the rest of the journey by night, stopping at out-of-the-way motels for the remaining days of the trip and receiving very strange looks from the night desk clerks when he checked in. Driving in west Texas near Stockton, he was following another car during a heavy rain storm when the lights of the car in front suddenly disappeared. This was followed by a wave of cold, icy, brown water breaking over the sides of Jerry's beloved MG car, swamping it. Both cars had driven into a hidden pool of flood water. To avoid stalling in the middle of the flood, Carr down-shifted and gunned the MG out the other side, but by now he was cold, shivering and soaking wet. After checking that the occupants of the other stationary car were okay, he drove another four miles, stopping at a filling station to inform the owners about the stranded car and its occupants. As he opened the doors of the MG to get out, a flood of water spilled out on to the driveway. Fortunately, the old MG managed to keep going and he made it to Clear Lake without further incident. [**4**]

'The Original Nineteen'

The arrival of the fifth group of astronauts coincided with a move to new offices on the third floor of Building 4 on the MSC site, offering additional office space and administrative support to the growing corps. The month before the group arrived to begin their training, Chief Astronaut Alan Shepard had reorganized the administrative management of the Astronaut Office (known internally as 'The Office' and which had the identification Code CB in the MSC organizational structure). On April 26, Shepard had written a memo to other astronauts and directorates across the MSC site, explaining the allocation of administrative 'Flights' under a 'Flight Leader' (a senior astronaut), which was intended to standardize the administrative operations without disrupting the astronauts' technical and flight responsibilities. For some time, requests for astronaut signatures, appearances and general correspondence, the administrative side of the role, had been increasing dramatically by the month. Before this got too out of hand, Shepard revised the system, freeing up the astronauts' training time as much as possible and affording them adequate preparation time prior to their flights. The whole Astronaut Office would now be spread across several offices on the 4th floor, with veteran and rookie astronauts sharing office space and a secretary. The 'Flight' listing (but not office floor plan) is given in Table 4.

Each member of the Astronaut Office hoped to fly in space at least once, which was, after all, the point of applying in the first place. The fifth group, at the very brink of commencing Apollo manned flight operations, naturally felt their chances for a flight to the Moon were very real. In the mid-1960s, the media was awash with stories looking towards the 1970s, with the exciting prospect of dozens of lunar flights, the creation of semi-permanent space stations and even a lunar research base. While these objectives were certainly part of NASA's long term planning, the truth was that neither sufficient funding nor the hardware were in place to support such possibilities. There was also little likelihood of political support to make these ideas a reality any time soon, a significant frustration for the space agency's grandiose plans.

By the summer of 1966, grounded astronaut Deke Slayton, then NASA's Director of Flight Crew Operations, found himself with more astronauts than he really needed for the immediate future, even without the planned second group of scientist astronauts due to

Table 4 Astronaut Office (CB) Reorganization, Effective: Mid-May 1966, 4th Floor Building 4, MSC

FLIGHT A	Groups	Spaceflights	FLIGHT B	Groups	Spaceflights	FLIGHT C	Groups	Spaceflights	FLIGHT D	Groups	Spaceflights	FLIGHT E	Groups	Spaceflights
1 *Carpenter**	1	1	1 *Cooper**	1	2	1 *Grissom**	1	2	1 *McDivitt**	2	1	1 *Schirra**	1	2
2 *Aldrin*	3	0	2 *Chaffee*	3	0	2 *Gibson*	4	0	2 MATTINGLY	5	0	2 *Stafford*	2	1
3 *Anders*	3	0	3 *Collins*	3	1	3 GIVENS	5	0	3 MCCANDLESS	5	0	3 SWIGERT	5	0
4 *Armstrong*	2	1	4 *Conrad*	2	1	4 *Gordon*	3	0	4 *Michel*	4	0	4 WEITZ	5	0
5 *Bean*	3	0	5 *Cunningham*	3	0	5 HAISE	5	0	5 MITCHELL	5	0	5 *White*	2	1
6 *Borman*	2	1	6 DUKE	5	0	6 IRWIN	5	0	6 POGUE	5	0	6 *Williams*	3	0
7 BRAND	5	0	7 *Eisele*	3	0	7 *Kerwin*	4	0	7 ROOSA	5	0	7 WORDEN	5	0
8 BULL	5	0	8 ENGLE	5	0	8 LIND	5	0	8 *Schmitt*	4	0	8 *Young*	2	1
9 CARR	5	0	9 EVANS	5	0	9 LOUSMA	5	0	9 *Schweickart*	3	0			
10 *Cernan*	3	0	10 *Garriott*	4	0	10 *Lovell*	2	1	10 *Scott*	3	1			

Notes:
*Denotes Chief of 'Flight'
Though listed alphabetically (below the 'Chief of Flight'), the groups were mixed and contained both veteran and rookie astronauts. The new Group 5 members (in capitals) were spread across the five 'Flights.' Flight A and Flight B contained three veteran astronauts with space flight experience; Flight C and Flight D included two space flight veterans; Flight E included four space flight veterans.

Status of Other Astronauts
Shepard – Chief Astronaut (Group 1; 1 spaceflight)
Slayton – Director Flight Crew Operations (Group 1, no spaceflights)
Glenn – Retired (Group 1, 1 spaceflight)
Freeman – Deceased (Group 3, no spaceflights)
Graveline – Resigned (Group 4, 0 spaceflights)

arrive the following year. With all the seats assigned for the remaining Gemini missions, the first Apollo test flights and the early lunar landing attempts, the hopes of an early flight for any new astronaut were soon dashed. Indeed, the chances for any flight *at all* seemed remote. In the interim, Slayton told the new astronaut group that after completing their general training, they would be given numerous technical assignments, supporting early flight crews in their preparation for a mission, or manning a console in Mission Control working as the Capsule Communicator (Capcom), with the singular responsibility of talking with the astronauts in space. Though not yet formally assigned to a 'flight crew,' many saw these assignments as a step in the right direction; a natural and extremely important support position for the complex Apollo missions, providing experience of preparations working towards their own flight assignments.

It was still a sobering thought, however, that any first flight for the new astronauts would remain some years away. Added to this was the challenge of integrating into the NASA system, while ensuring that their family settled into life in Houston. Some felt like they were surplus to requirements for quite a while, as they came to understand the reality of the 'pecking order' of seniority in the Astronaut Office, with the 'Original Seven' Mercury astronauts – still at the top of that tree – enjoying almost cult status in Houston. In a cheeky parody of this, the new group decided to label themselves the 'Original Nineteen.'

For their early training program, Slayton decided to merge the 19 new astronauts with members from the 1965 scientist selection. This fourth group had been the first non-pilot selection by NASA and had also found themselves as outsiders in the 'astronaut politics game' for a while. With more than a little tongue in cheek, the Group 4 members had branded themselves the 'Scientific Six,' until Duane Graveline suddenly left the program for personal reasons, thereby forcing the remaining scientist astronauts to rename themselves the 'Incredible Five.' Despite their apparent seniority to the 1966 selection, the scientists realized that the new pilot astronauts had a better chance of fitting in than they had. In fact, this turned out to be mostly true, as nine of the 19 flew in space before any of the five original 1965 scientist astronauts. Even under Apollo Applications/Skylab, five other members of the 1966 group flew in the more 'senior' position of Command Module Pilot (CMP) and only one of the scientists flew to the Moon, as a Lunar Module Pilot (LMP). Three of them eventually flew as solo Science Pilots on Skylab, much to the chagrin of the scientific community who wanted to see a Commander and two scientists crew each mission. It was therefore not surprising that the scientist astronauts soon worked out, not so half-jokingly, that the preferred pecking order for flight seats seemed to be headed by any of the original Mercury astronauts, then a test pilot, followed by a jet pilot astronaut. Next, they reasoned, would come the pilot astronauts' wives, and then probably the astro-chimps, before a scientist astronaut would get anywhere near a flight seat. This feeling persisted into 1967, when the second group of scientists arrived and labeled themselves the 'Excess Eleven' (XS-11), having been bluntly told they were not really needed at all. Taking this into consideration, it was not long before the jet-pilot-focused Group 5 astronauts realized that, with many veteran astronauts approaching retirement, they were actually not in such a bad position after all. [5]

Seconded to NASA

For the serving military astronauts, moving to a new duty station was part of the role of being in the armed forces, except in this case it was in the more publicly visible NASA than the normally closed military establishments. At least the family could look forward to more comfortable homes than most basic military married quarters, and hopefully settle in for a longer period than the normal military duty rotation period.

During the 1960s, the largest military contingency in the Astronaut Office comprised officers from U.S. Navy and the U.S. Air Force, with only a few from the U.S. Marine Corps. There were no U.S. Army astronauts until the Shuttle era. While each officer was operationally working at NASA, they were assigned administratively to the local reserve and recruiting branch of their parent service for the duration they remained at NASA or on active duty. The reserve branch took care of the administrative work associated with the individual and the parent service. As Jerry Carr explained, "NASA owned our bodies, but [the parent service] hung on to personnel and pay records." [**6**]

In subsequent selections, the military personnel were seconded to NASA for a 'tour of duty' of approximately five years, after which they could be recalled to their parent service or extend their association at NASA. This was not the case in the mid-1960s for military personnel in the Astronaut Office. "I was not aware of any tour of duty limit," Jerry Carr stated in 2008, and it was never mentioned by the Marines while he was there. As far as Carr was concerned, he was expected to remain at NASA "until they threw me out," or he decided he wanted to return to the Corps. In fact, in 1974 after he came home from his Skylab mission, he was informed by Headquarters USMC that he had been out of the normal sequence of duties for so long (by then 8 years) that it would have been difficult to find a place for him. Realizing he was unlikely to make the rank of general, Carr therefore remained at NASA for a further three years, finishing his 22-year military career in 1977 with the rank of colonel.

For many of the new astronauts, this removal from the normal sequence of appointments, experience and promotion was the price of diverting their career into NASA. As with Jerry Carr, when they did try to return to continue their career, it was often too late to progress any further. But that was far into the future, and with the prospect of a flight to the Moon a tempting assignment, the primary focus was to complete the training and get assigned to a flight, even if it did mean working in a support role for a few years.

A new life in Houston

Back in the early 1960s, one of the strongest supporters of the space program was Vice President Lyndon B. Johnson. As a proud Texan, he had lobbied to have NASA site their main astronaut training center in his home state. By September 1963, the new MSC in Houston was ready to accept its first personnel. Just two months later, following the assassination of President John F. Kennedy, Lyndon Johnson took over that role and was even more determined to beat the Soviets to the Moon. For a while, the political and financial support was in place to build a program to reach the Moon. NASA hoped it would continue, to enable the space agency to develop new, far reaching objectives for the 1970s and beyond.

The area that had been chosen for the MSC was pasture land formerly owned by Rice University. Now, six decades later, a vibrant metropolis and a thriving house building program exits there, with most of the community made up of NASA employees and contractors. In the early days, this was convenient for astronauts and workers alike, who could secure a suitable building plot or purchase an established house and commute the couple of miles or less to the center each day. It was in this environment that the new astronauts set up home for their families, although there were warning signs to watch for in choosing a home. When Al Worden was shown one potential shoreline building plot for a house, he noted the high-water mark from the last hurricane eight feet up the trunk of a nearby tree. Thus warned, he sensibly decided to look for something on higher ground. The problem was that most of the Clear Lake area lay on soft ground, requiring concrete pillars to be driven deep into the soft clay to support any substantial building.

With his family slowly growing accustomed to the heat and humidity of a Texan summer in Houston, Jim Irwin took his wife Mary around the local area in search of a suitable place to set up home, and showed her a large property up for sale at Bay Colony on Galveston Bay. After living in cooler and hillier Colorado, his wife took one look at the muddy waters of the bay and the flat, surrounding area, wrinkled her nose at the prevalent smell and said it had absolutely no appeal for her. Irwin realized that his plans for a nice two-story beach house on the property with a deck overlooking the bay were at an end, and he would have to allow Mary to decide where they would live. Eventually, they met a local architect who offered to design and build their dream home at Nassau Bay, with a sizeable price reduction on the building lot, "because I was an astronaut." The same cul-de-sac would later see Ed Mitchell, Don Lind and their families set up their homes there as well.

Fortunately for Jerry Carr, he had been able to secure an ex-show house in El Lago (Seabrook) for the new family home a short time after arriving at MSC. Little work was needed before they moved in, but if getting to Houston for the new astronauts could prove challenging, it was not all plain sailing for their families either. Carr's first wife JoAnn had arranged, with the help of a family friend, to drive the family station wagon down to Texas with all their six children. When the moving firm arrived to load up the family belongings, furniture and bulky items from the Carr's old house in Santa Ana, California, the removers were confronted with organized chaos, with six young children running around the almost empty house while JoAnn organized boxes for loading. The observation from one of the removal men was; "No wonder he wants to go to the Moon." Setting off for Houston on June 10, the drive took several days and was a trial of stamina and determination, staying in hot Arizona motels with six children and no cold water, with JoAnn snatching brief moments of sleep in the back seat of the car while the family friend carried on driving. Arriving in Houston, they had to stay in what was then called the Kings Inn for three or four days, as their house was not ready for them. In fact, as a former show house on a new estate, there were still empty plots either side of them when they did finally move in. According to JoAnn, the move to Houston was not expected to last more than ten years, but four decades later she was still living in the same house in Seabrook. [7]

Fame, but little fortune

The transition from rather sparse married quarters in the military to a purpose-built home in and around Clear Lake in Texas was a major improvement for the men and their families, not only in miles, but also comfort. That comfort was not just in bricks and mortar.

Some years earlier, the seven Mercury astronauts had secured a deal with Time Inc., and Field Enterprises, for exclusive access to their personal (but highly edited) stories. With just seven astronauts, it had proved a nice financial bonus to the family income, but as more astronauts were selected over the years, so the agreement was spread among ever larger numbers, reducing the individual's share. By the time the fifth group arrived, there were 50 astronauts and thus smaller shares in the pot, but nevertheless it helped.

As NASA's civilian astronauts worked for the government, or were serving officers in the military, most were never going to be millionaires, but a few did make shrewd investments which would pay dividends in later years. It has been assumed that astronauts earned large sums of money for being flung into space. After all, it was a highly dangerous occupation. But the truth was so much different. There have never been extra payments for any astronaut flying in space, so apart from standard out-of-town expenses of a few dollars a day, astronauts were never going to get rich working at NASA.

NASA Group 5 meets the press, May 2, 1966. (Rear from left): Brand, Bull, Duke, Engle, Evans, Haise, Irwin, MSC Director FOD Deke Slayton, PAO Paul Haney (standing). (Front from left): Lind, Lousma, Mattingly, McCandless, Mitchell, Pogue, Roosa, Swigert, Weitz and Worden. Missing, unable to attend, were Carr and Givens. (Courtesy Space Facts)

BACK TO CLASS

On May 2, 1966, seventeen of the nineteen new astronauts, accompanied by Deke Slayton, faced media reporters from newspaper, radio and television for the first time, in their debut press conference at the MSC News Center. Unable to attend were Ed Givens, who was still involved in USAF/AMU duties, and Jerry Carr, recovering from a three-day bout of measles. [8]

Their formal training would commence on May 9, 1966 and would be made up of 15 months of 'general training,' which included a program of ten science and technology courses, as well as a series of briefings on the Gemini and Apollo program, the hardware and support facilities. Interspersed with this would be the survival and wilderness training courses, environmental training and extensive geology training. Added into the mix were visits to contractors, public appearances and the support work for other missions. Keeping up personal fitness was the responsibility of the individual, who could take advantage of the facilities at MSC, the Cape, or other amenities. With such a tight schedule, jogging around the MSC site, as well as the long roads and beaches at the Cape, or even their own neighborhood area near the training center, became a popular and flexible activity for many astronauts.

The Class of '66 was joined at the start of their training program by two of the scientist astronauts, Joe Kerwin and Curt Michel. Both had earlier qualified as naval aviators and so were not required to complete the 12-month jet pilot course that their civilian colleagues, namely Owen Garriott, Ed Gibson and Jack Schmitt, were undergoing. Those three scientist astronauts would graduate from flight school on August 6, returning to MSC later that month to begin the general training program from September. At 24 (19 from Group 5 plus the 5 from Group 4), this was the largest group NASA had trained at one time, until surpassed by some of the Shuttle selections, and would put a strain on NASA's limited resources. For the new astronauts, one of their first assignments shortly after arriving at MSC involved being checked out as pilots in NASA's Lockheed T-33 (or *Shooting Star*) and Northrup T-38 *Talon* jet aircraft. These were the aircraft they would use for travel across the country to meet training requirements and for proficiency flying.

The program of ten science and technology seminars was conducted over a four-month period. This was followed by an intense series of system briefings for the Apollo Command, Service and Lunar Modules (CM, SM and LM). After six months in the classroom, the group would then 'go wild' on environmental and survival courses and continue with their geological studies. The academic program was designed to provide each astronaut with a common level of understanding in each topic, while the durations of the survival, environmental and geological training field trips were governed both by seasonal weather and the size of the group.

Nominally, the working week would begin with a Monday morning pilots' briefing, allowing Shepard and Slayton to update the group on the latest developments and results, as well as any technical assignments reports from astronauts who were the CB point of contact for that topic. The training courses ran from Monday (afternoon) to Wednesday (afternoon), followed by two days (Thursday and Friday) spent on operations, project briefings and field trips. Technically the weekend was their down time, but invariably the new astronauts would put in extra hours studying the week's lessons or preparing for the following week's assignments. In truth, there was very little 'down time.'

Informal 'bull sessions'

With such a large group to train and limited resources to do so, it soon became apparent to some members of the group that they would have to step in themselves to provide some additional teaching time. Following on from a series of discussions held the previous day, Ed Mitchell sent a memo on July 21 to all members of the Operations & Training Branch of the Astronaut Office (i.e. the Group 4 and 5 astronauts) on the subject of additional, informal seminars (termed 'bull sessions'), which were designed to supplement formal class lectures. [**9**] The memo stated that "the objective is to provide discussions of the fundamental ideas and principles prerequisite to an understanding of the systems lecture." These sessions were voluntary, with each astronaut responsible for organizing his time around his other commitments, so that they could attend these sessions as required or as they saw fit. Each group leader determined where and when the sessions were held. As the coordinator for the effort, Mitchell hoped to participate in as many sessions as he could, and asked for other qualified persons to lead discussions. At the time of the memo, these topics included: Flight Mechanics (led by Al Worden); Hypersonics (also Worden); Physics of Space (Group 4 scientist Curt Michel and Don Lind from Group 5); Propulsion (Jack Lousma); Space Medicine (Group 4 scientist Joe Kerwin); Guidance and Control (Ed Mitchell taking Inertial Systems, Inertial Instruments and Space Navigation, and Charlie Duke leading the Servo Theory sessions).

These 'bull sessions' were fitted around the more formal training syllabus sessions, which are detailed below and time-lined in Table 5

Science and technology

Geological training: As the main objective of the Apollo program was to explore the Moon from orbit and from its surface, geology training became an integral element in the whole training program, with a series of class studies totaling 112 hours divided into two 56-hour programs of instruction. Geology I included 14 sessions focusing upon terrestrial mineralogy, petrology, and geological processes. The objective was to teach the astronauts how to recognize basic rock structures and the processes required for geological mapping. Geology II involved 15 sessions, with the emphasis on lunar geological features, geological mapping, geophysical studies and basic techniques in sampling. There were also 14 sessions on mineralogy and petrology. This would also prove useful training for AAP missions that would operate in Earth orbit, since one of their mission objectives would be to study our planet from space over a long duration.

Across the 15 months of general training, the group completed a series of at least ten geological field trips. The first of these trips occurred less than a month after they had arrived at MSC and the final one was completed just prior to the selection of the new group of scientist astronauts (Group 6) (Table 6)

Table 5 GROUP 5 ACADEMIC AND PRACTICAL TRAINING 1966-1967

GENERAL SCIENCE, FAMILIARIZATON, ORIENTATION & SURVIVAL TRAINING
NASA ASTRONAUTS CLASS OF 1966: 19 MEMBERS OF GROUP 5
May 1966 – September 1967

DATE	TIME	COURSE/VISIT TOPIC
MAY – DECEMBER 1966		
May 1	N/A	Official reporting date for Group 5 intake
May 9	2 hrs	Geological Processes I: orientation session
May 9	2 hrs	Physics of Upper Atmosphere and Space I
May 9	2 hrs	Digital Computers I
May 10	2 hrs	Mineralogy and Petrology I
May 10	2 hrs	Astronomy I
May 11	2 hrs	Medical Aspects of Space Flight I
May 11	2 hrs	Digital Computers II
May 16	2 hrs	Geological Processes II: terrestrial geological processes
May 16	2 hrs	Physics of Upper Atmosphere and Space II
May 16	2 hrs	Digital Computers III
May 18	2 hrs	Digital Computers IV
May 19	2 hrs	Mineralogy and Petrology II
May 19	4 hrs	Apollo Project Familiarization – Mission Profile Briefing
May 19	3 hrs	Astronomy II
May 23	4 hrs	Medical Aspects of Space Flight II & III
May 23	2 hrs	Geological Processes III: geologic principles
May 24	2 hrs	Mineralogy and Petrology III
May 24	2 hrs	Astronomy III
May 25-27	3 days	Apollo Project Familiarization – Launch Vehicle familiarization – visiting Marshall Space Flight Center, Huntsville, Alabama
May 31	2 hrs	Geological Processes IV: stratigraphy and geologic time
May 31	2 hrs	Physics of Upper Atmosphere and Space III
May 31	2 hrs	Astronomy IV
Jun 1	2 hrs	Mineralogy and Petrology IV
Jun 2-3	2 days	Geological Field Trip to Grand Canyon
Jun 6	2 hrs	Geological Processes V: lunar geologic processes
Jun 6	4 hrs	Flight Mechanics I & II
Jun 7	2 hrs	Flight Mechanics III
Jun 7	3 hrs	Astronomy V
Jun 8	2 hrs	Mineralogy and Petrology V
Jun 8	2 hrs	Flight Mechanics IV
Jun 9-10	2 days	Celestial Recognition Training at Morehead Planetarium, Chapel Hill, North Carolina
Jun 13	2 hrs	Geological Processes VI: structural geology
Jun 14	4 hrs	Flight Mechanics V & VI
Jun 14	2 hrs	Physics of Upper Atmosphere and Space IV
Jun 15	2 hrs	Mineralogy and Petrology VI
Jun 15	2 hrs	Flight Mechanics VII
Jun 15	2 hrs	Medical Aspects of Space Flight I
Jun 16	2 hrs	Flight Mechanics VIII

(continued)

Table 5 (continued)

Jun 16	2 hrs	Medical Aspects of Space Flight II
Jun 20	2 hrs	Geological Processes VII: geologic mapping
Jun 20	2 hrs	Flight Mechanics IX
Jun 20	2 hrs	Physics of Upper Atmosphere and Space V
Jun 21	2 hrs	Medical Aspects of Space Flight III
Jun 21	4 hrs	Flight Mechanics X & XI
Jun 22	2 hrs	Flight Mechanics XII
Jun 23-24	2 days	Geology Field Trip to West Texas
Jul 5-8	18 hrs	Spacecraft Familiarization – North American Aviation instructors deliver general briefings on Command and Service Module
Jul 11	2 hrs	Geological Processes VIII: rock-forming processes
Jul 11	2 hrs	Guidance and Navigation I
Jul 11	2 hrs	Medical Aspects of Space Flight IV
Jul 12	4 hrs	Meteorology I & II
Jul 13	2 hrs	Mineralogy and Petrology VII
Jul 13	2 hrs	Physics of Upper Atmosphere and Space VI
Jul 14-15	12 hrs	Spacecraft Familiarization – Briefings by Grumman instructors on the Lunar (Excursion) Module
Jul 18	2 hrs	Geological Processes IX: Earth structures and landforms
Jul 18	4 hrs	Guidance and Navigation II & III
Jul 19	4 hrs	Guidance and Navigation IV & V
Jul 20	2 hrs	Mineralogy and Petrology VIII
Jul 20	2 hrs	Rocket Propulsion I
Jul 21-22	2 days	Spacecraft Familiarization – CM and LEM mock-ups were used to acquaint group with controls and displays in both vehicles
Jul 25	2 hrs	Geological Processes X: Earth structures and landforms
Jul 25	2 hrs	Communications I
Jul 25	2 hrs	Mineralogy and Petrology IX
Jul 27-29	3 days	Geology Field Trip to Bend, Oregon
Aug 1	2 hrs	Geological Processes XI: geophysics
Aug 1	4 hrs	Guidance and Navigation VI & VII
Aug 2	4 hrs	Guidance and Navigation VIII & IX
Aug 3	2 hrs	Mineralogy and Petrology X
Aug 3	2 hrs	Rocket Propulsion II
Aug 3	2 hrs	Communications II
Aug 4-5	2 days	Visit to Kennedy Space Center, Florida for briefings on Apollo launch site facilities, procedures and operations
Aug 8	2 hrs	Geological Processes XII: geophysics
Aug 8	4 hrs	Guidance and Navigation X & XI
Aug 9	4 hrs	Guidance and Navigation XII & XIII
Aug 10	2 hrs	Mineralogy and Petrology XI
Aug 10	2 hrs	Rocket Propulsion III
Aug 10	2 hrs	Communications III
Aug 11	Unknown	Recovery Operations – Recovery Operations Branch brief astronauts on plans for recovering the Apollo CM at the end of the mission

(continued)

Table 5 (continued)

Aug 15	2 hrs	Mineralogy and Petrology XII
Aug 15	4 hrs	Guidance and Navigation XIV & XV
Aug 16	4 hrs	Guidance and Navigation XVI & XVII
Aug 17	2 hrs	Rocket Propulsion IV
Aug 17	2 hrs	Communications IV
Aug 18	4 hrs	Geological Processes XIII & XIV: lunar structures, stratigraphy and landforms
Aug 18	2 hrs	Communications V
Aug 18-19	2 days	Mission Control Center Operations – Flight Operations directorate staff brief group on MCC-H facility and operations
Aug 21-25 or 22-26	4 days	Geology Field Trip to Katmai, Alaska [conflicting dates]
Sep 12-20	47.5 hrs	CSM Systems Training I
Sep 16	2 hrs	Mineralogy and Petrology XIII
Sep 21-23, or 25 only	1 day	Geology Field Trip to Valles Caldera, New Mexico [conflicting dates]
Sep 26-Oct 11	47.5 hrs	CSM Systems Training II
Oct 13 – Nov 3	82 hrs	LEM Systems Training
Nov 7-15	9 days	Environmental Familiarization – Launch and Entry Acceleration using the centrifuge at MSC
Nov 14-22	9 days	Launch Vehicle Abort training
Nov 17	½ day per man	Wilderness and survival training – Water Survival I lectures
Nov (29 or) 30-Dec. 2	3 days	Geology Field Trip to Pinacates, Mexico [conflicting dates]
Dec 5	1 day	Environmental Familiarization – Pressure suit indoctrination
Dec 8-9	1 day per man	Wilderness and survival training – Water Survival II at Water Safety and Survival School, Naval School of Pre-Flight, Pensacola, Florida
JANUARY – SEPTEMBER 1967		
Jan 24-27	1 day per man	Environmental Familiarization – Weightlessness using an USAF KC-135 aircraft
Feb 6	2 hrs.	Geologic Processes I
Feb 6	2 hrs	Mineralogy & Petrology I: History and Classification of meteorites
Feb 12-19	8 days	Geology Field Trip to Hawaii
Feb 27	2 hrs	Geologic Processes II: lunar depressions, cold traps and heat flow
Feb 27	2 hrs	Mineralogy & Petrology II: tektites and shock metamorphism in
Mar 6	2 hrs	Geologic Processes III: impact cratering
Mar 6	2 hrs	Mineralogy & Petrology III
Mar 13	2 hrs	Geologic Processes IV: structure and petrology of large impact craters
Mar 13	2 hrs	Mineralogy & Petrology IV
Mar 16-17	2 days	Geology Field Trip to Pinacates, Mexico (Make up trip)

(continued)

Table 5 (continued)

Mar 20-24	4 days	Geology Field Trip to Hawaii (Make up trip)
Mar 27	2 hrs	Geologic processes V: remnant magnetism in extra-terrestrial materials
Mar 27	2 hrs	Mineralogy & Petrology V
Apr 10	2 hrs	Geologic Processes VI: shock metamorphosed rocks and tektites
Apr 17	2 hrs	Geologic Processes VII: Interpretation of Orbiter 2 and 3 photos
Apr 17	2 hrs	Mineralogy & Petrology VI
Apr 24	2 hrs	Mineralogy & Petrology VII
May 1	2 hrs	Mineralogy & Petrology VIII
May 8	2 hrs	Mineralogy & Petrology IX
May 8	2 hrs	Geologic Processes VIII: soil mechanics
May 15	2 hrs	Mineralogy & Petrology X
May 16-19	4 days	Geology Field Trip to Zuni Salt Lake, Hopi Buttes & Meteor Crater Arizona
May 22	2 hrs	Mineralogy & Petrology XI
May 22	2 hrs	Geology IX: geophysics
May 29	2 hrs	Mineralogy & Petrology XII
May 29	2 hrs	Geology X: tektites
May 31-Jun 2	3 days	Geology Field Trip to Zuni Salt Lake, Hopi Buttes & Meteor Crater, Arizona (make-up)
Jun 5	2 hrs	Geology XI
Jun 5	2 hrs	Mineralogy & Petrology XIII
Jun 12-16	5 days	Wilderness and survival training – Tropical survival training, USAF Tropical Survival School, Albrook AFB, Panama Canal Zone
Jun 22-23	2 days	Geology Field Trip to Medicine Lake, California – postponed because of snow
Jul 2-8 (or 3-8)	6 days	Geology Field Trip to Iceland [conflicting dates]
Aug 7-11	5 days	Wilderness and survival training – Desert survival training, Air Force Survival School, 3635th Flying Training Wing, Stead AFB, Nevada
Sept 21-22	2 days	Geological Field Trip to Pinecates (make-up but no details)
No dates given	12 hrs	Control Task Training – Gemini Part Task Trainer used for Orbital attitude and maneuver control; retrofire control; re-entry control and terminal rendezvous. The group also completed multiple 2-hour sessions on the Translation and Docking Simulator

NOTE: The five Active Group 4 astronauts also participated in these courses, taking the overall group size to 24. Attendance for the sessions varied due to other commitments and could be as low as two, but normally numbered between 9 and 24.
The program included a program of Series I Geology Training courses from May 9 to September 16, 1966. The Series II Geology Training courses were taken between February 18 and June 5, 1967.

Table 6 NASA Astronaut Class of 1966, Group Geological Field Trips June 1966- July 1967

Field Trip #	Dates of field trip	Main Location	Specific training locations
1966			
1	June 2-3	Arizona	Grand Canyon
2	June 23-24	West Texas	Marathon Basin and Santa Elena Canyon
3	July 27-29	Bend, Oregon	Newberry Crater and Lava Butte
4	August 21-25 (or 22-26)	Katmai, Alaska	Valley of the Thousand Smokes
5	September 21-23 (or 25 only)	Los Alamos, New Mexico	Valles Caldera
6	November 29 (or 30-December 2)	Pinacates Volcanic Area, Mexico	Cerro Colorado and Elegante Craters
1967			
7	February 12-19	Hawaii (island)	*[Just over two weeks after the Apollo 1 pad fire]*
7a	March 16-17	Pinacates, Mexico	*Make up trip for four Group 4/5 astronauts*
7b	March 20-24	Hawaii	*Make up trip for seven Group 4/5 astronauts*
8	April 26-28 [Delayed to May 16-19, see below]	Flagstaff, Arizona	Sunset Crater Area and Meteor Crater
8a	May 16-19	New Mexico	Zuni Salt Lake, New Mexico; Hopi Butte & Meteor Crater, Arizona
8b	May 31-June 2	New Mexico	Zuni Salt Lake, New Mexico; Hopi Butte & Meteor Crater, Arizona *(Make up trip for four Group 5 astronauts)*
9	June 22-23	Medicine Lake Area, California	*[Just over 2 weeks after the loss of Givens]*
10	July 2-8 (or 3-8)	Iceland	Askja Caldera, and Lake Fissure Area

Jerry Carr found the geology trips fascinating, except for the food in the field in Iceland. There, every meal included mutton for the meat course, which no one liked. As he recalled, "I felt it tasted like a wet wool sweater." When the camp was told that they were to be served up hot dogs for dinner one evening the mood improved, until everyone discovered that the sausages were also made from mutton! As challenging as that might have been, Carr still enjoyed the work and established some great relationships with members of the U.S. Geological Survey and various universities who accompanied, guided and trained the pilots-turned-budding-geologists. Disappointed at not being able to use these acquired skills on the Moon, Carr was pleased to renew those acquaintances and refresh his skills in preparing for his Skylab flight and the Earth Observation Program he assisted in from orbit. [10]

Skylab 4 crewmember Bill Pogue recalled, in his 2011 memoir, that the formal geology training trips sometimes provided moments of light relief. Towards the end of their first visit to the Hawaiian Big Island, Jim Irwin had organized a side visit to the Hawaii State

Prison to view the small trinkets prisoners made from monkey pod wood. As they drove towards the prison through the remote areas, Irwin decided to speed up to ensure they arrived before the store in the prison which sold the trinkets closed. Unfortunately, as they were approaching the prison, he drove a little too fast, alerting a highway patrol car which pulled them over. After Irwin explained their reason for the trip, his colleagues saw the officer burst into laughter. Irwin explained later that he'd told the officer that they were astronauts trying to get into the prison before it closed. [11]

Reviewing geological field maps during geology training. (From left): Lind (in hat), Swigert, Worden (chin in hand) Haise, Brand, Mattingly (looking at map) and Carr. [Inset] Participating in a geological field exercise in Hawaii.

Astronomy: A total of 15 hours, in five sessions, were spent studying astronomical terminology, the structure and composition of the solar system and the celestial sphere. These studies also included a trip to the Morehead Planetarium, in the University of North Carolina campus, on June 9 -10, 1966. [12]

Digital Computers: Four sessions, totaling eight hours, were completed, during which the group received tuition on the components of digital computers and how to program and operate them.

Medical Aspects of Space Flight: Over six sessions, the astronauts spent 17 hours trying to understand how the environment of space affects the human body.

Flight Mechanics: The 12 sessions in this topic totaled 24 hours of study and included the science and techniques of flying in space, in Earth orbit and at lunar distances, the theory and practical applications and implementations of mid-course corrections, and the mechanics of re-entering the Earth's atmosphere (in the Apollo CM) at the end of the mission.

Meteorology: At the time of the academic training, most thoughts were directed toward the Apollo series of missions to the Moon, but there remained several Gemini missions to fly before the end of 1966. The first few Apollo missions were to be flown in Earth orbit, putting the Saturn launch vehicle, spacecraft and support teams through their paces before committing to lunar distance missions. Therefore, it was important for the new astronauts to study the meteorological conditions on spaceflight operations, both for launch and landing, and for observations from Earth orbit. As later missions were being planned for extended duration in Earth orbit under the AAP (later Skylab) program, an observational understanding of global weather systems was an added advantage. The astronauts studied this topic for 4 hours over two sessions.

Guidance and Navigation: Instruction took over 34 hours across seventeen sessions, during which the astronauts were instructed in, and practiced, navigational techniques, with special emphasis upon the Apollo guidance and navigation systems they were intending to use in space.

Rocket Propulsion: Four sessions, totaling 8 hours, were devoted to the operational side of rocketry. The course reviewed the performance parameters of rockets, the components and differences between liquid and solid propellant rockets, and the operational use of a reaction control system.

Communications: After studies covering the basic concepts of communications, the astronauts studied radio ranging, radio telemetry and the telecommunications performance of Apollo systems. This series of lectures totaled 10 hours in five sessions.

Physics of the Upper Atmosphere: Six sessions, totaling 12 hours, focused on studies of the environment of the interplanetary medium and the effect of the Sun on that environment, on Earth's upper atmospheric conditions and associated phenomena. As a specialist in this area, Group 4 scientist astronaut Curt Michel acted as one of the lecturers on this topic to the rest of his colleagues.

Operational Briefings

These began the same month that the astronauts arrived at NASA and continued through the initial training program. Interspersed between the science and technology courses was a series of briefings and visits, divided into two phases, on the main hardware associated with Project Apollo and the ground facilities being developed to support flight operations.

Apollo Project Familiarization: This aspect of astronaut training began on May 19, with a four-hour briefing on the Apollo Mission Profile, including an explanation of the objectives of the program, the proposed launch schedules, a general description of the CM, SM and LM and briefings on the proposed Apollo lunar mission profiles from launch to splashdown. Between May 25 and 27, a group of 20 astronauts visited the Marshall Space Flight Center in Huntsville, Alabama, for a familiarization program on the Saturn launch vehicles. Those attending included 18 of the new nineteen astronauts, plus Group 4 astronauts Joe Kerwin and Curt Michel. Only Bruce McCandless did not attend, as he was still working on his doctorate thesis at Stanford University at the time. [**13**] Briefings were held on the components, systems and operational plans for the Saturn 1, Saturn 1B and Saturn V. The group also toured the facilities at Marshall, as well as the Mississippi Test Facilities where the huge Saturn engines were test fired. During these visits, they had the opportunity to witness one of those test firings. Then, over a two-month period totaling 30 hours of instruction, the group was instructed on the Apollo spacecraft they were hoping to fly. Firstly, North American Aviation instructors presented a series of general briefings, totaling 18 hours, between July 5 – 8, on the CM and SM. This was followed over July 14 and 15 by twelve hours of briefings on the LM. In addition to the 30 hours of briefings, they completed an additional two days of familiarization using mock-up displays and controls for the CM and the LM. Once the astronauts had completed their formal academic program, they would undergo complete and very detailed systems briefings on both spacecraft prior to their inclusion in the crewing roster. Such was the intensity of this control and display briefing, together with the size of their training group, the team was split into two groups for reviewing the mock-ups in Building 5 on site at MSC.

Space Flight Operations Familiarization: This phase of their training, held during August 1966, included further tours and briefings which were used to explain to the astronauts the operational side of human spaceflight. It was split into three main areas, covering launch, flight and recovery operations. Firstly, the team visited the Kennedy Space Center (KSC) in Florida on August 4 and 5, to receive briefings on spacecraft and launch vehicle operations, launch preparations and countdown activities at the Cape. The astronauts toured the Apollo Checkout Building, the Vehicle Assembly Building (VAB), the Launch Control Center (LCC), and the Apollo Launch Complexes (LC-34, 37 and 39). A couple of weeks later, during August 18 and 19, the astronauts were shown around the Mission Control Center (MCC), located in Building 30 at MSC. Here, staff from the Flight Operations Directorate fully briefed the astronauts on the MCC facility, including offering a description of each of the Flight Control positions in the Mission Operations Control Room (MOCR, pronounced 'Mocker') and an explanation of how each Staff Support Room functioned and operated as part of the broader mission support structure (which became an important element during the aftermath of the Apollo 13 explosion and recovery of the crew). During their visit, the astronauts were also briefed on the huge amount of data that flows from the worldwide tracking network and Mission Control during a mission. The final briefing in this round of training occurred on August 11, in which members of the Recovery Operations Branch gave several detailed presentations on the planned recovery process for Apollo, both from Earth orbit and for returning lunar missions.

Spacecraft Systems Training

Upon completion of their formal academic training, and with the geology training ongoing, the astronauts completed a series of very detailed spacecraft systems briefings. This involved eight intensive four-day weeks, with each day's instruction lasting a full six hours, and utilized specialist instructors from North American Rockwell (for the CSM) and Grumman (for the LM), using the appropriate systems trainers to provide hands-on practical experience to supplement the hours of theory.

The program of briefings and training on the CSM, given by NAR instructors, lasted 95 hours in total and was completed between September 12 and 20, and then between September 26 and October 11, falling either side of their fifth geology field trip to Los Alamos, New Mexico. CSM systems training comprised eight courses: structures (6 hours), electrical power system (12 hours), crew systems (6 hours), communications (8 hours), environmental control systems (12 hours), sequential events control system (15 hours), propulsion systems (12 hours) and stabilization and control systems (24 hours).

Between October 13 and November 3, a similar series of briefings, conducted by instructors from Grumman Engineering Aircraft Corporation, covered the LM and its systems. This series included courses on structure and mechanical systems (6 hours), electrical power systems (10 hours), instrumentation (6 hours), crew systems (6 hours), communications (6 hours), environmental control (12 hours), propulsion (12 hours) and guidance, navigation and control (24 hours).

Environmental Familiarization

As the training of astronauts is naturally focused on preparing them for living and working in space, it was logical to include training that could best reproduce microgravity's conditions on Earth. The difficulty was in trying to reproduce the unique conditions of a spaceflight, such as microgravity, in addition to launch or entry acceleration and deceleration loads, and then extend it over a protracted duration, or at levels not normally associated with flying high performance jets. This phase of the training also introduced the group to pressure garments intended for spaceflight operations, a step up from the aircraft pressure garments they would have become accustomed to in their operational flying careers.

Launch and entry accelerations: Conducted during November 7 to 15, 1966, this element of the astronauts' training utilized the centrifuge located in MSC Building 29 to simulate Apollo launch and entry acceleration profiles of up to 15G. For this series of runs, the astronauts were divided into groups of three, simulating an 'Apollo crew.' They were seated in an early Apollo CM couch and console configuration, but without any active controls or the majority of live instrumentation. There was, however, a 'G' meter to record the level of induced gravitation forces being experienced, an event timer to track events and reactions, and, simulating a real mission, a running commentary on mission events, involving appropriate crew responses over the radio link as the runs progressed. Crew station positions and acceleration profiles had to be pre-programmed into the central computer of the centrifuge and the crew needed to make the correct motions to simulate whatever task or commentary was required of them. Each of the astronauts completed two sessions, which had to be separated by 12 hours to allow sufficient time to recover. There were three training periods available, at 09.00 a.m., 11.00 a.m. and 1.30 p.m. each day across the nine days. Session 1 featured four runs. Run 1 was a nominal launch (and helped settle the astronauts into the simulator). Run 2 followed an entry using the Service Propulsion System (SPS) on the SM, while Run 3 replicated a Pad Abort. Run 4 was a High-Altitude Abort using the Launch Escape System (LES). The second session, the next day, also featured four runs. The first was again a nominal launch, while the second was an entry using the Reaction Control System (RCS) engines. Run 3 followed the minimal altitude abort by the SPS systems and finally Run 4 was a maximum (15G) SPS abort.

Weightlessness: In the 1960s, the common terminology for microgravity was weightlessness, or zero-g, and that is how this phase of their training was designated. Using a modified USAF KC-135, stripped of most of the interior seating and padded for protection, the aircraft flew a profile of parabolic trajectories, with each of the 18 to 20 parabolas flown reproducing 'weightlessness' for about thirty seconds. With a large group of 24 astronauts needing to experience this activity, they were divided into groups of three, spread over two flights each day for four days. This gave each of the astronauts one day's activity and about

9-10 minutes of weightlessness during the stomach-churning series of parabolas. This activity occurred between January 24 and 27, 1967. The evening of the final day of training was also the time of the tragic Apollo 1 pad fire at the Cape.

Pressure Suit Indoctrination: On December 5, 1966, representatives from the Crew Systems Division presented a program to introduce the men to the Apollo Block II pressure garment, similar to the garment they would be using when finally assigned to missions. The program of briefings and demonstrations included details of the design and configuration, how to put it on (donning) and take it off (doffing) in full and zero-g, the mobility of the suit at 3.5 psi differential pressure, and the range of miscellaneous crew equipment, with appropriate demonstrations. During the course, each astronaut gained experience in donning training versions of the suits and in their mobility. During their technical assignments and subsequent roles on support and back-up crews, the astronauts would finally get to wear pressure garments specially made for training, thus adding to their knowledge and experience in preparation for working with the actual, personally-fitted suits they would wear during a mission.

Jungle survival instruction. (Standing from left): Weitz, Brand, Swigert, Mattingly, Pogue, Lousma, Evans, Schmitt (Grp. 4), Lind, Mitchell, and Duke. (Kneeling from left): Carr, Roosa, Michel (Grp. 4), Kerwin (Grp. 4), Haise, McCandless, and Gibson (Grp. 4). [Inset] Roosa, Mitchell and Worden.

Survival Training

During the 1960s and 1970s, the nominal mode of recovering a U.S. space crew was from the ocean, with pickup by the U.S. Navy. From Project Mercury in 1961 through to Apollo-Soyuz in 1975, all returning American astronauts were recovered in this manner. In an emergency, of course, there was no guarantee that the crew would come down in the water. It might mean a landing in a wild and remote area of land, and a long wait to be recovered. All astronaut groups were therefore given a series of 'survival courses' to prepare them for unexpected landings in remote, inhospitable areas. Once the Space Shuttle was introduced, with its capability for planned runway landings on the continental United States or other suitable runaways around the world, this aspect of astronaut training changed considerably, and was re-named 'wilderness training' as the desert and jungle training no longer applied. In the 1960s, Apollo flight profiles restricted the recovery zones to mid-latitude locations on Earth (within approximately 30 degrees north and south of the equator), therefore tropical, desert and water survival courses were part of the astronaut training program for fifteen years. Unlike the Soviet cosmonauts, whose missions flew at a higher inclination, Arctic survival training was not included in the NASA astronaut training program until the 1990s and the inclusion of astronauts on Russian Soyuz crews flying Mir and ISS residency missions.

The objective of preparing the crews this way was to give them the confidence and ability to deal with an emergency or off-nominal landing situation. For military pilots, the training was an extension of the survival training they had already completed as part of their regular service. This type of training was divided into three phases. Firstly, trainers provided lectures and briefings in survival techniques for each type of environment. These were followed by demonstrations of survival methods, which were at first explained and then practiced. Finally, a field exercise was conducted, for the group to apply both the academic and practical training in a simulated survival situation.

Instead of attempting to complete all the survival training back-to-back, it was decided to spread the courses throughout the academic and familiarization program.

Water Survival: The NASA Recovery Operations Division instructed the astronauts in the academic program, which encompassed all the requirements for a human to survive at sea; including the food and water requirements, the effects of drinking sea water, sourcing food from the sea and how symptoms from prolonged exposure to sea conditions in a survival situation could be identified and, where possible, avoided or treated. These lectures occurred on November 17 and lasted for half a day, with half the group attending the morning session and the other half in the afternoon. There was then a two-day trip (December 8 and 9, 1966) to the Water Safety and Survival School, located at the Naval School of Pre-Flight, in Pensacola, Florida. Initially, the astronauts worked in an enclosed water tank without a pressure suit, perfecting basic swimming strokes from competition pace to endurance mode. They then performed underwater escapes from a submerged cockpit, using the *Dilbert Dunker,* a simulated aircraft cockpit on rails which slid from a high platform into the swimming pool. Beneath the water, the device tipped upside-down with the crewman strapped inside. Under the watchful eye of attending frogmen, the men had to effect a rapid escape, just as they would from a ditched plane. Next, the astronauts practiced boarding a life raft from the water and conducted helicopter pickups using both a sling and then a seat. This course took each man a full day to complete, totaling 1.5 man days for the entire group.

After the course in escaping from a submerged aircraft, the men were sent off to the Aerospace Defense Command's Life Support School at Perrin AFB near Sherman, Texas. Here, they were taught how to free themselves from a parachute being dragged across the water by high winds and from under a collapsed parachute in calm waters. This training was completed two years after arriving at NASA, over May 26 and 27, 1968, as well as during a refresher training course for other astronauts and MSC staff during July 8 and 9 that year on Lake Texoma, the large lake created by damming the Red River valley between Texas and Oklahoma.

Following studies and demonstrations of some issued equipment, the astronaut trainees received expert information on the will to survive, pre- and post-ejection procedures, personal survival equipment and rescue processes, and self-aid. During this instruction, the astronauts were also given a talk on the proper procedures to follow in ejecting from an aircraft, followed by a demonstration of techniques to use in getting loose from a parachute after it is no longer needed.

Then came their simulated ejection training – including sound effects – from a 35-foot tower. This involved a jerky, plunging, five-second ride down a cableway from the tower, during which they were required to perform a check of their canopy, release and deploy a survival pack, and open the safety covers over two parachute releases before they came to an abrupt, twisting halt. They then had to release themselves from their parachute harness. Helicopter hoists were employed as the means of getting the subjects to the top of the jump tower, and each man had four 'rides' on the simulator. Another session followed, in which each astronaut trainee was dragged along the ground by a full parachute canopy, billowed out by a wind machine capable of producing wind speeds of up to 60 miles an hour. In this exercise, they had to release at least one of the parachute attachment points to collapse the canopy. Next, they donned a parachute harness, which was attached by straps to the rear of a powerboat. They had to stand on a platform at the back of the boat and practice jumping into the water forward or backward, before being dragged through the water on their backs or face down until they released themselves from the harness. Further training involved launching them by parasail from the shore of the lake, using an 800-foot tow rope attached to a powerboat. They would reach altitudes of around 400 feet before the boat slowed, allowing them to descend and splash down in the water, after which they were picked up by a second boat. This exercise was then repeated with the astronaut kitted out with a survival pack. After splashing down in the lake, they had to struggle into a one-man life raft and paddle to shore[1].

Those taking part in this session included Brand, Carr, Engle, Evans, Garriott, Gibson, Lind, Lousma, Mattingly, McCandless, Michel, Mitchell, Pogue, Roosa, Weitz and Worden. [14] One of these refresher courses was reported in NASA's *Space News Roundup*

[1] NASA required its astronauts to complete water survival refresher courses every three years. Until June 30, 1971, this was at Perrin AFB, but when that base closed down it was then conducted at Homestead AFB, in southern Florida.

bulletin, in which a four-day course in life support at Perrin AFB was squeezed into two days for a total of 156 astronauts and various members of MSC staff. This was the two-day refresher course on Lake Texoma. Astronauts participating included Aldrin, Bean, Haise, Irwin, Kerwin, Mattingly, Schweickart and Swigert. [15]

Tropical Survival: A five-day program was held towards the end of their basic training, during the week of June 12, 1967. This stage of their training was managed by the USAF Tropical Survival School at Albrook AFB, Panama Canal Zone. The familiar pattern of a series of academic and demonstration training was followed by a three-day field exercise, this time in the jungle. After being dropped off in the jungle came an experience few would forget. Being in a rainforest it was very wet, so their chosen attire was to wear the long johns supplied with the Apollo CM kit.

Haise (right) and Swigert tow a colleague (Bull) in a raft down the Chagris River during jungle survival training. Irwin and Weitz follow in the second raft. [Inset] Lousma during water survival training.

In his 2011 memoir, Al Worden noted that on the walls of the jungle classroom, during the academic part of the course, it appeared that some of the stuffed animal heads were moving. Worden looked closer and saw live boa constrictors slithering around the trophies. Don Lind also mentioned the memorable snakes; indeed, one just over Charlie Duke's head stuck its forked tongue out. Later these snakes were prepared for the astronauts' lunch. Lind also remembered the comment from one of the instructors that "there wasn't a chance in ten thousand that we would see a snake in the wild, because they were so few and far between." However, shortly afterwards, one of the instructors excitedly reported seeing one of the largest deadly coral snakes he had ever seen, just at the edge of the school buildings. After that, Lind mentally reassured himself with the thought, "Well, that's my one chance in ten thousand. I won't see any more snakes." [**16**] He certainly jinxed himself, as during the third day of the course, while tramping through the jungle behind Fred Haise, they suddenly came across a huge, seven-foot fer-de-lance, an extremely venomous reptile that could easily paralyze a man. The snake was captured and placed in a burlap sack. The guide assured the astronauts it would only strike things it could see, so stuffed inside the sack where it was dark, the deadly snake would remain calm. This did not exactly appease the astronauts carrying the snake, just in case it didn't know the rules about only striking in daylight. Bruce McCandless carried the bag out of the jungle and on to Panama City after the course finished. The snake was then put in a wire cage and brought to the United States, with McCandless having previously checked that the viper could be imported into the country as long it was clean. The U.S. Customs at the airport said that it could not be imported, but McCandless quoted the regulations, which said that providing there was no infection in its ears, it could be brought in. Perhaps wisely, the customs official declined to personally inspect the reptile to make sure it was keeping its ears clean. The snake duly entered the United States and was donated to the Houston Zoo Viperarium [**16**].

Lind also respected the severity of some of the rain storms in Texas, but these were light and gentle spring showers compared to the deluges experienced in the Panama jungle. They had set their camp at least eighteen feet higher than "a small babbling stream," but less than two days later, after a heavy storm, the water was cascading down the sides of the hill to such an extent that Lind recalled, "in ten or fifteen minutes, the formerly small stream had risen by about fifteen feet and was forty feet wide."

The group managed to break three machetes hacking through the undergrowth and these had now washed away in the storm. In Lind's opinion, the machetes were terrible. Instead of purchasing them locally in Panama for about five dollars each, NASA had designed its own blades for the Apollo astronauts. The 'unrealistic' specifications, as Lind explained, including having to be "made of stainless steel, which meant we could not sharpen them." There was also an integral saw-tooth knife on one side, which was intended as a saw, "but instead of making U-shaped teeth, [they] used V-shape teeth, which meant that at the bottom of each 'V' was a stress point." This meant that they were brittle. On one occasion, Lind was in competition with a Panamanian local, who was using a sharp knife to chop down 18-inch diameter trees stretching up to 70 feet into the sky. Suddenly, the blade on Lind's machete broke and flew off, embedding itself in a tree fifteen or twenty feet away, and about a foot above the head of the suddenly white-faced Jack Swigert, who had been resting against the same trunk. As these were new tools under evaluation for use on Apollo missions, the subsequent astronauts' report would, they hoped, ensure that this design was deleted from the survival kit.

Bill Pogue explained that the Apollo survival kit included food and water for each man for three days, saying; "people believed if a rescue team could not find us in three days, we probably would not be found alive." [17] Pogue described the jungle as "a very interesting place, I was surprised by how much the nights cooled off." Having been lulled to sleep in his parachute hammock by the rhythmic sound of a coordinated chorus of insects, the sudden silence as the sun rose proved to be a great alarm clock. Though he had succeeded, as part of the exercise, in cutting down a palm tree to extract the heart of the plant at its core, supposedly a delicacy, "we speculated whether the energy we consumed from eating the heart of the palm was as great as the energy expended in harvesting it."

Pogue also recalled the difficulty encountered by the helicopter crews assigned to drop supplies to them as planned. The group had been told that if they heard a helicopter, they should light a camp fire so that the search and rescue crew could locate them and airdrop food supplies. Pogue's trio decided to light a large fire, mainly from kindling created by the straw huts they had built from the local vegetation. It certainly made a great signal fire, but also created a lot of smoke. An added problem was that each of the three-man teams were relatively close to each other and all had the same idea, so the whole valley was soon wreathed in smoke. This made flying helicopters even more difficult, having to wait for the smoke to clear to successfully drop their supplies. This would probably have worked better if the helicopter had been looking for just one three-man crew, as on an Apollo mission, rather than eight trios.

After eating, the group had to walk to the Chagris River, where the support team handed them a three-man life raft, similar to that supplied in the Apollo survival kit. This enabled them to float downstream to a native village, a journey which Pogue recalled was "like an amusement park ride on steroids." At the village, the trainees enjoyed lunch provided by the villagers, which thankfully was not derived from the trussed-up iguana centerpieces. Pogue also explained that after the course had been completed, they flew to a local AFB for a reception held by the American Ambassador to Panama. However, exhausted from their jungle ordeal, they politely excused themselves when they could for a well-earned rest in their hotel rooms, in a real bed with clean sheets, before making the trip back to Ellington Field the following day.

Desert Survival: Another 5-day course, held in the week of August 7, 1967, just three days after the second scientist astronaut selection had been named, was run by the Air Force Survival School, 3636th Flying Training Wing (named in the accompanying *Roundup* article as the 3636th Combat Crew Training Group (Survival) ATC), based at Stead AFB, Nevada. It took place, not surprisingly, in the heat of Fairchild AFB, near Spokane, Washington State. The Cascade Mountains caused the moisture in the air masses moving from the Pacific to fall as rain on the western slopes and by the time the front passed over the mountain to the east side there was little moisture left, resulting in the desert conditions. Don Lind, who originated from Utah, had not even realized there was a desert in Washington [State] "or that it could get so hot. During the day time, land temperatures reached 157 degrees F." [18]

Apollo desert survival training in Washington State. (Standing from left) Swigert, AF Col. Chester Bohart, Mattingly and Duke. [Inset left] Engle, Carr and Worden construct a water still. [Inset right] John Bull dressed for the desert. (Courtesy Ed Hengeveld).

This time, the activities of the group were kept to a minimum due to the desert conditions. Divided into three-man 'crews,' each trio used the parachutes for shade and an Apollo life raft as a lounger for sleeping. They found that by digging down into the sand, it would be cooler to stand or sit on. The groups also fabricated a condensation trap to collect water, which meant digging a small funnel-shaped hole in the desert with a collection container for the liquid in the base. Above this, the astronauts laid out a sheet of parachute material, weighted at the edges and with a rock placed in the center which pressed the canopy down to suspend the apex of the parachute material above a collection cup. As the temperature rose, the collected, impure water gathered on the outside, where it was evaporated by sunlight. Pure water vapor condensed on the cooler inside of the parachute material, dripping down the sides of the material and into the collector for later retrieval and consumption. All eighteen astronauts from Group 5 (Givens had been killed two months previously) and three from Group 4 (Kerwin, Gibson and Garriott) participated.

Lectures and classroom activities took place on Day 1 (August 7) and the following day (August 8), they were taken to the field area near Pasco, Washington, and Lewiston, Idaho, about 130 miles south of Spokane, where they participated in a two-day field demonstration (August 8 and 9). Once again, they split into teams of three and were taken to sites in the desert, where they would stay until August 11 (Day 5). [19] Charlie Duke found the desert terrain boring and, having to spend most of the day in the shade, not much fun. Additionally, the solar evaporator water collector his group made never worked well. [20]

Underwater training

By the time the Group 5 astronauts were receiving their academic and basic training in 1966, the use of large water tanks as simulation devices for EVA had been under evaluation for three years. The results of the evaluation led to the conclusion that neutral buoyancy in large water tanks was an excellent training resource for spacewalking techniques. [21]

During the EVAs attempted on Gemini 9, 10 and 11, the astronauts had encountered difficulties, lacking adequate body restraints and over exerting themselves physically in trying to complete their tasks. For the final mission, Gemini 12 in November 1966, underwater simulations of EVA techniques in training, coupled with the availability of more efficient foot and body restraints, gave EVA astronaut Buzz Aldrin sufficient understanding and better equipment with which to complete his tasks, more comfortably and on schedule. Since then, underwater simulations have become a standard training technique across the world for EVA preparation. [22]

Recognizing that such techniques would become a standard part of astronaut EVA training for Earth orbit missions, the training program for the new astronauts included scuba diving certification, as a first step qualification for wearing full pressure garments underwater to simulate EVA operations. A scuba diving qualification course was held in the Florida Keys, a skill which many of the astronauts found very useful, both for their professional careers and in their personal lives after leaving the Astronaut Office, such as while on vacation around the world. Lind recalled the training in his 1985 biography, noting that learning to dive in the Florida Keys was not always straightforward and that "every time we dived in, the instructors called it 'going down with the hungries,' [meaning the sharks]." [23]

A group of NASA astronauts attend a scuba diving course. (Standing from left): Bill Anders, Dave Scott, Al Worden, Rusty Schweickart, Tom Stafford, Jim Lovell, Gene Cernan, Stu Roosa, Jim McDivitt, Neil Armstrong, [unidentified], Ken Mattingly, Ed Givens, Mike Collins, [unidentified], Jerry Carr, C.C. Williams and Joe Engle. (Kneeling from left behind training staff): Jack Schmitt, John Young, Dick Gordon, Curt Michel, Buzz Aldrin, [unidentified].

Control Task Training

Part of mastering the ability to fly an Apollo CM involved time spent on part-task trainers that could replicate the side-arm rotational and transitional controllers. Several devices were made available to allow the astronauts to become familiar with the peculiarities of Apollo control systems. The simulators were fitted with replicas of the Apollo CM controls and displays, optical displays of the Earth and stellar background out of the windows and a variety of suitable rendezvous targets.

Gemini Part-Task Trainer: None of the Group 5 astronauts were assigned to fly the Gemini spacecraft, therefore in-depth training was not required. In any case, with the assigned crews for the remaining Gemini 9 through 12 missions already deep in training, there would be little time available for the new astronauts to train in depth on the systems before the program ended. But as each Gemini crew completed their training, more time became available for familiarization as fewer flight crews required scheduled simulator time. By using this trainer, the new astronauts could experience simulated orbit attitude control, maneuver thrust control and retrofire, terminal rendezvous and nominal re-entry control, using the three modes of pitch, yaw and roll. The astronauts also practiced rate command, direction (or acceleration) and pulse control.

Jim Irwin wrote about this phase of their training in his 1973 memoir, saying: "We were nearing completion of the Gemini program and we could see Apollo coming up. My group was not studying anything on the Gemini systems. We were working with Apollo systems, but we were still using the Gemini docking simulator. We would fly this Gemini vehicle and dock with the Agena in this huge room, 200 feet long and 100 feet high, where the simulator was suspended on tracks, so we could go up and down, side to side, and fore and aft. We could physically translate docking with another spacecraft." [24]

Each of the nineteen astronauts had to master:

- *Orbital altitude and maneuver control:* Initially, they used cockpit reference systems to conduct attitude control and thrusting maneuvers in all three modes of pitch, yaw and roll. Then, they repeated the exercises using out-of-the-window displays. In these simulations, particular attention was given to mastering cross-coupling.
- *Retrofire control:* In these training sessions, the astronauts could use the 8-ball attitude indicator, together with the out-of-the-window horizon display, to practice utilizing attitude control to correct misalignment torques by using rate command and direct control modes. During the simulations, the instructor could vary the misalignment torques to constantly challenge the astronauts completing the simulations.
- *Re-entry control:* Each astronaut practiced damping oscillations in both pitch and yaw, as well as controlling the roll to the commanded position in both rate command and direct control modes.
- *Terminal rendezvous:* Using cockpit displays of range and range rate, together with the flight direction indicator, the astronauts practiced this maneuver by viewing electronically projected images of the target, displayed under varying conditions.

Translation and docking simulator: This involved multiple two-hour sessions to give the astronauts the physical process of the final docking phase. Each man practiced rate command, direct and pulse control modes with different initial conditions.

Launch Vehicle Abort Training

The Dynamic Crew Procedures Simulator (DCPS) was utilized to train the astronauts in a range of launch abort profiles. This gave them an appreciation of situations they hoped would never happen, but which they knew they had to be prepared for. During the simulations, a variety of booster malfunctions were replicated, and could include several abort situations in rapid succession. For this phase of their training, which was completed from November 14 to 22, 1966, the astronauts, together with their Group 4 colleagues, were teamed up into four 'crews' of three (A-D) during the day. Each 'crew' then completed two normal runs, six engine or propulsion system failures, three propulsion failures, three staging or sequential failures, eight control failures and two structural failures.

Aircraft Flight Proficiency Training

Even though all the 19 newly selected astronauts were highly experienced jet pilots, they all had to be instructed in the use of NASA's T-33 and T-38-type aircraft. These training jets were assigned to MSC and flew out of nearby Ellington AFB, just north of the Space Center, near the Hobby regional airport. The astronauts used them throughout their careers for cross-country and local flying requirements. By the time the new group arrived at NASA, the older T-33 *Shooting Star* had been in service for about 20 years but, while outdated, the astronauts found the T-33 operated better in icy weather and for taking trips to the northeast of the country during the winter months. Of course, the favorite aircraft was the more modern, sleek and faster T-38 *Talon*.

As all the candidates from the fifth group were qualified jet pilots, it was certainly unusual for them to board multiple passenger planes to go off on group field trips. The number of available T-38s was limited, so it was easier to embark on such trips as a group rather than fly in several jets. But a cautious NASA did not want to risk losing a large group of its astronauts to any potential crash of a single aircraft. Flying the T-planes was fine, as they only had two seats, but using the larger planes invoked a NASA rule that only a limited number of active astronauts could be on board each aircraft. But it was not all fast jets. Arriving a day early during one trip to Iceland, they got the chance to try their hand at sailplanes, or gliders. In jets, there was little need to use the rudder, but in gliding, there is a lot of rudder input. Don Lind admitted that he was always being chastised to use more rudder pedal. He felt better when he asked former X-15 pilot Joe Engle how he got on with the glider: "Well, not too good," one of the best test pilots in the United States at the time admitted. "The guy was all over me about not using enough rudder," Engle added.

Helicopters: On December 2, 1966, Alan Shepard issued a memo to all astronauts relating to helicopter training. The memo stated: "I have recently informed certain individuals in the first three selected groups of astronauts that they are to continue helicopter flying." Though the names of those individuals were not mentioned in the memo, Shepard continued, "Those of you in these groups whom I have not mentioned are expected to discontinue their helicopter flying as of this date." This decision presumably created the group of helicopter qualified veteran astronauts who were targeted for the Commander or LMP seats on early Apollo missions, and those who would not continue helicopter flying, who would likely be assigned to Senior Pilot (later renamed CMP) seats on either the early Earth orbital Apollo missions or AAP missions. This meant they had little prospect of progressing to the initial Apollo lunar landing crews. In the memo, Shepard continued, "Approximately 50 percent of the last two selected groups ('The Original Nineteen plus the Incredible Five') will be informed of their selection to helicopter training at Pensacola. It is expected this training will commence around February 1967." [25]

Rather than the normal twelve-month course, the astronauts were each given just two weeks of helicopter familiarization training, provided by the Naval School of Pre-Flight, NAS Pensacola, Florida, which they then continued back at Houston for a further two weeks. This training was linked to early familiarization with the proposed lunar landing trajectories they would fly in the Apollo LM. Over the next few years, each of them had to maintain their helicopter proficiency training in preparation for assignment to an Apollo landing crew, as well as preparing for more advanced training in the Lunar Landing Training Vehicle (LLTV), commonly known as 'the flying bedstead,' which mimicked the flying and handling characteristics of the LM. Once assigned to a landing crew, the Commander received LLTV training, but all astronauts were allowed to keep up their helicopter training skills until after the end of the Apollo program.

An associated hand-written, but undated note headed 'Choppers' from Curt Michel's papers archived at Rice University, gives more information on those training assignments for the Group 5 and 4 astronauts, assignments presumably discussed at a Monday morning pilots' meeting in the Astronaut Office in early 1967. The schedule to begin helicopter training during February and March 1967, as recorded by Michel, was: Duke and Engle (February 13); Brand and Bull (February 27); Givens and Haise (also February 27); Pogue and Roosa (March 8); Irwin and Lousma (March 10); Group 4 scientist astronaut/geologist Jack Schmitt and Worden (March 22); and finally, Mattingly and Mitchell (March 24). Michel added the observation that this represented 20 percent of the fourth group of scientist astronauts and 68 percent of the fifth group. Those yet to receive helicopter training dates (who Michel labeled as Kiwis – meaning flightless) were, from Group 4, Garriott, Gibson, Kerwin and Michel himself and, from Group 5, Carr, Evans, Lind, McCandless, Swigert and Weitz.

In his 2011 memoir, Bill Pogue wrote, "My entire selection group went through helicopter training at the Pensacola Naval Air Station. The course normally lasts one year, but we had only four weeks. We enjoyed every minute of it." [26] Pogue explained that, to retain their qualification in helicopters, the astronauts had to take one up for a short flight each week. In the summer months, the doors on each side were removed to "open the airflow in the south Texas heat."

In 2008, Jerry Carr recalled that training program in the late 1960s. He had spent eleven years as a Marine fighter pilot, "studiously avoiding any possibility that I might be assigned duty as a helicopter pilot. Suddenly, I found myself praying that I would be sent to helicopter training," [27] According to his records, Carr received his helicopter training certification in September 1968.

In March 1967, Owen Garriott from the CB Experiment Group sent a memo to Al Shepard, making a strong case for Don Lind to be included in helicopter training, given his prior research into high energy physics, solar winds and associated lunar interactions, and his collateral assignment in developing the design of the Apollo Lunar Surface Experiment Package (ALSEP). Garriott reasoned that it would be “desirable to have at least one astronaut with experience in physics research prepared to participate in an early manned landing” on the Moon. In the memo, Garriott also conceded that for the rest of the Experiment Group (himself, Ed Gibson, Bruce McCandless and Curt Michel), immediate assignment to helicopter training would not be a priority, as their chances of being assigned to a landing mission were, perhaps, “far in the future [and that] if their time was devoted to helicopters, their other work on Earth orbital missions will be necessarily reduced.” Once such an opportunity became available, Garriott suggested that priority listing for helicopter training should be given to Michel, then himself, then McCandless and finally Gibson. [28]

Al Worden during helicopter training. (Courtesy Ed Hengeveld)

THE PILOT INSIDE THE ASTRONAUT

There were only two Apollo-era astronauts who actually experienced aerial combat duty in Vietnam, both from the Group 5 selection in 1966: Ron Evans and Paul Weitz. In fact, Weitz’s NASA biography page records that he received a commendation medal for “combat flights in Vietnam.”

In an interview with *Air & Space* magazine's Jennifer Ross-Nazzal, Jan Evans revealed that life for her and her late husband was tough during his two tours of duty in Southeast Asia, and his years at NASA after moving into their new house in Clear Lake in 1966 were very easy to take by comparison. When asked to define the difference between being a Navy wife and the wife of an astronaut, Jan Evans admitted that while there was a lot of squadron camaraderie, "You couldn't talk. You never said where your husband was or what his job was. The wives would get together, but some were in great fear. Frankly, they were not pleasant to be around, because the majority of us still went on to live and had our children and our activities." [29]

When Ron Evans was selected as a NASA astronaut, he was serving his second combat tour in Vietnam, flying off the aircraft carrier *Ticonderoga*. Highly regarded as a pilot, he flew a hundred combat missions over Vietnam, earning a Navy commendation and seven other medals. "He got home the 28th of April, [and] had to report to NASA the 2nd of May," Jan recalled. "So we did a lot of washing and ironing, and he was on his way. The children and I went down after they got out of school in June. Once we got to NASA, we saw much more of Ron. When he was a Navy fighter pilot, he would be gone anywhere from six to 10 months at a time; home four months, gone again six, eight, 10 months; home for a month. In Houston, we got to see him almost every weekend for at least 24 hours. In fact, I felt like I was having Friday-night affairs." [29]

Following his selection by NASA, Ron Evans did not speak much about his experiences in Southeast Asia, although he did admit, "It scares the hell out of you." It did concern him that while he was training to fly into space, he still had a lot of friends serving in the Vietnam conflict. Some were even prisoners of war. [30]

Despite the inherent danger in what they were doing as astronauts, sitting on top of massive Saturn rockets engorged with highly-volatile fuel, many admitted to occasional bouts of guilt about their squadron friends who were still serving in Vietnam and daily laying their lives on the line flying dangerous sorties over enemy territory (some never to return), while they, as astronauts, were far removed from the conflict and having fun riding rockets into space. Those who paid the ultimate price in the Southeast Asian conflict included several top pilots who had unsuccessfully gone through the selection process for NASA or MOL astronaut training.

Following the tragedy of the Apollo 1 pad fire several astronauts – thought to be around six in all – began formulating a plan to take on a combat tour. According to historian Greg Goebel, in his essay *Race to the Moon, 1957-1975,* it seems to have been something of a half-baked idea in hindsight, "but at the outset of the manned space program, a stint as an astronaut was thought of as a temporary duty assignment, with the astronauts returning to formal military service after three years. Of course, astronaut training turned out to be very exhaustive and it wouldn't have been practical to cycle people around at such a rate." Goebel also pointed out that a tradition had been established by NASA in the early days of Project Gemini, giving an astronaut a promotion in rank after achieving their first space mission, which ensured that training and flying with the space agency would not be seen as any sort of retardant to their military career, which many wanted to continue after they left NASA. [31]

In his 1999 memoir, Gene Cernan recalled that: “Private talks around the Astronaut Office, bull sessions over drinks after work, and long discussions during weekend barbeques, hatched an idea. Why wait in Houston doing nothing? If Pete Conrad, Dick Gordon, Al Bean, myself and/or any other astronaut was sharp enough to fly spaceships for NASA, we could certainly polish up our carrier landing qualifications and get into that Vietnam scrape, where our military skills could be used during the lull in the space race. Even before we took the idea to Deke, we knew he wouldn’t like it, but we had to try, if for no other reason than to ease our consciences.” [32]

As Director of Flight Operations, Deke Slayton was entirely sympathetic when approached with the proposal, but on behalf of the space agency, he had to spell out what might happen if they took it up. “Deke probably thought our plan was about as dumb as anything he had ever heard,” recalled Cernan, “but sticking to his iron rule, he said the door was open anytime we wanted to leave, quite a courageous act on his part when faced with possibly losing a half dozen or more veteran astronauts. But, he added, did we really understand what was involved? ‘You can go, but I won’t guarantee a job when you come back,’ he said.” [32]

Goebel also acknowledged that the pilots flying in Vietnam had become increasingly opposed to the continuation of the war. “One astronaut was told: ‘You don’t want to be here. It’s a bad idea.’ Then the armed services blasted the idea completely out of the sky: if the astronauts came back to operational service, there was no way they would be sent on combat missions, since if they were shot down and taken prisoner, the North Vietnamese would play up the capture of an astronaut for all it was worth.” [31] As Cernan said in summing up, “Our scheme squelched. Vietnam would not be our war.”

Week in the Barrel

One of the most challenging events in the training calendar for many of the astronauts was to master the skills of dealing with the media and performing public appearances across the country. All members of the group had served in the military at some time, and were unused to the glare of publicity the role of an astronaut brought them. Of the 19 chosen in 1966, perhaps former X-15 pilot Joe Engle was the most familiar to the public, but even the exposure of that program was nothing compared to what faced them as a NASA astronaut. For many astronauts, overcoming nerves and a fear of public speaking is a more daunting prospect than training for a mission, or indeed flying the mission itself.

As NASA is a government funded agency and accountable to the tax paying public and politicians, PR roles remain part of an astronaut’s agenda. They are required to visit contractors, talk to workers, tour schools and institutions, speak before Congress, be interviewed by representatives of the media, and conduct formal press conferences and speeches at functions, symposia and events. Usually these speaking engagements, corporate events and ‘press-the-flesh’ occasions were an exhausting and unavoidable part of an astronaut’s designated activities. They came to be known among them as their “week in the barrel,” after a rather ribald joke – best not related here – which was a metaphor for having to endure something unpalatable.

As challenging as this assignment might be, the astronauts soon warmed to the support and generosity shown by the public, especially children, and appreciated the effort the workforce put into their part in developing and creating space hardware, however small. The sense of pride and satisfaction in a job well done was supported and encouraged by the astronauts as they toured around the country. Over the years, their skills of public speaking and meeting the public developed, supported by Public Affairs Department of NASA, and remains one of the most engaging elements when meeting or listening to a member of the Astronaut Office. On the other side, there is always a guarded awareness of media spin and sensationalism, so a level of trust and professionalism must be built up and earned over many years to encourage astronauts to tell their story, and to reveal details of their experiences and missions which were not always forthcoming in official reports and presentations.

SUMMARY

"One of the things that is professionally satisfying about the space program is the technical and scientific training we were given along with the various assignments," wrote Don Lind in 1985. Charlie Duke recalled that they all acted like sponges, sopping up as much information as they could. It was often tough – a Shuttle astronaut once described it as like "drinking from a fire hose" – but it was a major learning curve for all of them. Nevertheless, Vance Brand thought the training worked well in preparing them for the Apollo program. Following the survival training courses, the group split to follow individual CSM or LM assignments.

A year after their selection, most of the academic, survival and basic training for the Group 5 (and Group 4) astronauts had been completed. This was just as well, as a new group of scientists (Group 6, August 1967) were about to embark on their training process, with a four-month academic program between October 1967 and February 1968. As with the previous scientist astronaut selection, Group 6 would then commute to a 12-month jet pilot training program, from March 1968 until the spring of 1969, before going on to complete the remaining survival training courses prior to joining the Astronaut Office and receiving their first technical assignments.

During this time, the members of the 1966 selection would be working on their own technical assignments, supporting the early Apollo and Apollo Applications programs and missions. Their training had afforded them the necessary skills to work on the missions leading up to the first lunar landings and to assist in the development of the Orbital Workshop concept, as well as participating in studies of future programs and research fields, and relating these developments to the public, politicians, workers and institutions. None had yet flown in space, but the time was approaching for the first of the group to be named to a flight crew.

Between the summer of 1966 and the end of 1969, and with many veteran astronauts assigned to the final Gemini and early Apollo missions, or on the verge of retirement, there were opportunities for the Group 5 astronauts to engage themselves in future support roles. This would afford them more experience and skills, which they could call upon when the day came that they learned of their own assignments to backup or flight crews and took another a step closer to the launch pad taking them into space.

References

1. ***Falling to Earth***, Al Worden with Francis French, Smithsonian Books, Washington, DC, 2011
2. ***But for the Grace of God***, William Pogue, Soar with Eagles publishers, 2011, p. 197
3. ***To Rule the Night***, Jim Irwin with William Emerson, Holman, 1973, p. 197-201
4. ***Around the World in 84 Days, the Authorized Biography of Skylab astronaut Jerry Carr***, David J. Shayler, Apogee Books 2008, pp. 24-26
5. ***NASA's Scientist-Astronauts***, David J. Shayler, Colin Burgess, Springer-Praxis, 2006
6. Ref. 4, p. 59
7. AIS interview with JoAnn Carr, May 2002
8. *Meet the Press and Visa-Versa,* MSC Space News Roundup Vol. 5 #15 May 13, 1966 p. 1
9. Memo from Edgar Mitchell to Operations & Training Branch Astronauts, dated July 21, 1966, from the Curt Michel Collection, Rice University, copy in AIS archive
10. Ref. 4, pp. 68-69
11. Ref 2, pp. 200-201
12. *With their Eyes on the Stars*, MSC Space News Roundup July 8, 1966 p. 5
13. *New Astronauts Visit MSFC For Saturn Booster Briefing*, MSC Space News Roundup Vol. 5 #15, May 13, 1966, p. 2
14. *Ejection Training Achieves Realism,* MSC News Release MSC68-39, May 31, 1968; Space News Roundup June 7, Vol. 7 #17, 1968 p. 2
15. *Whoa, Whoa You Son-of-a-Gun!* MSC Space News Roundup Vol. 7 #20, July 19 1968, p. 3
16. ***Don Lind, Mormon Astronaut***, Kathleen Maughan Lind, Don Lind, Deseret Book Co., Salt Lake City, UT, 1985, pp. 79-80
17. Ref 2, pp. 204-206
18. Ref 16, p. 77
19. *MSC Pilots Scheduled for Desert Survival Training*, MSC Roundup Vol. 6 #21 August 4, 1967, p. 1
20. ***Smoke Jumper, Moon Pilot: The remarkable life of Apollo 14 astronaut Stuart Roosa***, Willie G. Moseley, Acclaim Press, 2011, p. 106
21. *A personal history of underwater neutral buoyancy simulations,* G. Sam Mattingly with John B. Charles, The Space Review, February 4, 2013, www.thespacereview.com/article2231/1, last accessed November 8, 2016
22. ***Walking in Space***, David J. Shayler, Springer Praxis, 2004
23. Ref 16, p. 76
24. Ref. 3, p. 201
25. Memo from Alan B. Shepard Jr to all astronauts, December 2, 1966, from the Curt Michel Collection, Rice University, copy in AIS files
26. Ref 2, p. 198
27. Ref 4, p. 71
28. Memo from Owen Garriott to Alan Shepard, March 16, 1967, from the Curt Michel Collection, Rice University, copy in AIS files
29. Smithsonian *Air & Space* magazine, article, "The Astronaut's Wife: Jan Evans recalls how it was for the families of moon voyagers in the Apollo era," by Jennifer Ross-Nazzal, issue June 2013

30. ***Apollo: A Decade of Achievement***, Paul I. Casey, JS Blume Publishing, New York, NY, 2013
31. *Race to the Moon: 1957-1975*, Greg Goebel, (in the public domain), March 1, 2015. Available online at: http://www.vectorsite.net/tamrc_05.html#m6. Last accessed November 12, 2016
32. ***Last Man on the Moon***, Gene Cernan and Donald Davis, St. Martin's Press, New York, NY, 1999

5

Supporting Apollo

"We choose to go to the Moon in this decade and do the other things, not because they are easy, but because they are hard."
U.S. President John F. Kennedy,
Rice University, Houston, Texas,
September 12, 1962.

By the end of 1966, NASA's latest group of astronauts were settling into their new life and career in Houston. Balancing their busy training schedule with finding a new home, settling the children in school and, when they were able, dealing with routine domestic duties, kept their diaries full. On top of all that, the clock was ticking down towards the end of the decade and President Kennedy's deadline for landing Americans on the Moon.

Less than five months after arriving in Houston, and still deep into their academic training, the 'Original Nineteen' received their first technical assignments to support the initial Apollo manned missions across a variety of areas. Their participation allowed the primary and backup crews to focus on their mission training, without having to attend routine meetings or keep track of all the small developments across the program which were a part of each mission. The technical roles also offered the new astronauts a useful insight into the hardware, procedures and programs they were involved with, as well as the inner workings of NASA. Life at the Manned Spacecraft Center (MSC) was very different to the military organizations they were used to; a bureaucratic government agency, sited within an engineering campus-like environment, with both on- and off-site facilities supporting its operations. Less than five years old, the still expanding MSC was neither an academic nor an industry institution, but was developing an identity of its own.

D.J. Shayler, C. Burgess, *The Last of NASA's Original Pilot Astronauts*,
Springer Praxis Books, DOI 10.1007/978-3-319-51014-9_5

ASSIGNMENTS TO APOLLO 1966–1969

The late 1960s were the 'Golden Days of NASA,' when anything seemed possible, including reaching the Moon in under four years. While none of the Class of '66 would fly in that decade, their input into the early Apollo missions was crucial to the overall success and achievements those historic flights attained by the summer of 1969.

Grand plans, without substance

Deke Slayton might not have needed the new intake to fill flight seats immediately, but he welcomed their help in supporting missions that were just months away. As the program accelerated, it also expanded, becoming more complicated and making it increasingly difficult for the original members of the relatively small Astronaut Office to keep track of progress – or the lack of it – across so many areas. Just five years earlier, the seven Mercury astronauts were personally involved in many aspects of that program, but now, as Gemini ended and Apollo commenced, the seven-strong CB complement had expanded to around 50, pushing resources to the limit. The astronaut technical assignments in the mid-1960s began to diversify, such as establishing important direct links with contractors and vendors, the flight controllers, engineers, technicians and scientists, to provide a vital bridge to their busy colleagues who were training for or flying the missions. These missions were not limited to those heading for the Moon, because there were also the Earth-orbital test flights of Apollo hardware to complete, as well as the development of extensive scientific missions planned for the early 1970s under the Apollo Applications Program (AAP).

On March 23, 1966, less than two weeks before the new Group 5 astronauts were named to the public, NASA released its first AAP schedule. It was a more than optimistic one, with no less than 45 flights planned over the next ten years; 26 launches on the Saturn 1B and 19 on the huge Saturn V. Though they had been chosen too late for inclusion in the early Apollo missions already in development, NASA's long-term plan envisaged assigning members of the new Class of '66, together with the earlier 1965 scientist astronaut selection and the one which would follow in 1967, to crew these advanced missions.

If the new astronauts were confused by Slayton's reticence towards their appointment in 1966, it was because he doubted that these proposed missions would actually fly at all, let alone on time. The fact that there was no evidence of the hardware to support the plans, nor the funds to continue the production lines, supported his viewpoint. Faced with the significant personal commitment to move families and careers to Texas, it is not surprising that some of the new group had a few reservations about the future.

If everything worked out as planned, however – once the initial mainstream Apollo missions had achieved the goal of landing a man on the Moon by the end of the decade – there was a reasonable expectation that a series of further, more adventurous lunar flights and the Orbital Workshops (OWS) would both be authorized. Logically, this would build upon the huge effort undertaken to prove the Apollo system worked and in reaching the Moon in the first place. If Apollo *could* safely place men on the Moon by 1969 (and in 1966 there was expectation, but no guarantee, that this was possible), then all the hard work and expense to get there would be justified. It therefore seemed sensible to capitalize further on all that by establishing a firm foothold not only on the surface of the Moon, but also in low Earth and lunar orbits, as well as creating a regular logistics system to support that network. To achieve this, the planning had to be in place and initiated years in advance, to ensure that when the time came, there were firm objectives, clear missions, available hardware and trained crews to attain the new goals.

When the Class of '66 arrived at Houston in early May, the buzz around the MSC was that dozens of missions were being planned, so clearly each man needed to complete his training and gain the necessary technical knowledge and support experience prior to being assigned to a flight.

Steps to the Moon

In the short term, and with the perception that the Soviets were racing America to the Moon, a projected plan for Apollo missions into 1969 was already in place. From 1967, the first manned Apollo flights were intended to evaluate the capabilities of the Block I Command and Service Module (CSM) systems, in preparation for more complicated follow-on missions. While these Block I spacecraft lacked the capability to rendezvous and dock with the Lunar Module (LM), or travel to the Moon, they were capable of supporting three-man crews for up to 14 days on Earth-orbital 'shake-down' missions. The decision to move to the more capable Block II CSM, which *could* fly to the Moon and operate in conjunction with the LM, was originally dependent upon the success of these flights. Confidence gained from the success of a series of unmanned missions meant that just two Block I missions were planned, widely identified as Apollo 1 and Apollo 2. Since the beginning of the year, 12 astronauts, chosen from members of the first three astronaut groups, had been in training as a quartet of three-man teams for the prime and backup positions on these two missions.

Apollo 3, using the Saturn 1B, would begin a series of missions to evaluate the Block II lunar mission hardware. From Apollo 4 on, NASA would rely solely on the Saturn V. It was expected that four missions (Apollo 3 through 6) would utilize the improved CSM spacecraft, test fly the LM in space and man-rate the Saturn V ready for the first attempted landing missions. If all went well, the flights of Apollo 7, 8 and 9 would be available either as lunar landing qualification missions, or as backup flights to overcome any delays or setbacks that might be encountered on the earlier missions. Those three missions would be capable of performing the first lunar landing attempts, but only if the previous missions went to plan. That first landing, when it occurred, was planned to last at least eight days and to include one short lunar surface EVA, of no more than three hours, during a stay time of about 18 hours. It was expected that, barring any major setbacks or problems, the primary goal of landing a man on the Moon and returning him safely to Earth, set by President John F. Kennedy in 1961, would be met by the planned ninth manned mission. By December 1969, that primary objective would hopefully have been attained more than once. These were the missions which members of the 1966 astronaut selection were expected to support and, perhaps in the latter stages, occupy the backup positions.

Once the initial lunar landing had been achieved, it was projected that the Apollo lunar program would be wound down after perhaps no more than ten short-stay landings, with the emphasis shifting to AAP. At this point, there would be a clear division between advanced lunar missions, with both orbital and surface activities, and Earth-orbital operations. Both branches of AAP (lunar and Earth orbital) were expected to support missions lasting several weeks, using the projected (but ultimately never flown) Block III CSM with a variety of advanced LM configurations, a series of Saturn Orbital Workshops, and specialized solo scientific flights in Earth orbit. These missions were expected to fly throughout the 1970s and at least well into the 1980s. It was with these flights in mind that the 19 new astronauts had been chosen.

More advanced, long term planning projected extensive operations, not only around the Earth or at the Moon, but out into deep space – primarily looking towards Mars – and hopefully at a pace which would still see some of the members of the Class of '66 in the Astronaut Office and able to participate in these missions. That was the grand plan, and it looked great *on paper*. But the realities were far from certain and, as we now know, never materialized the way it was forecast, thus dramatically changing the potential careers of those in the Astronaut Office.

Dreams in doubt

Hoping to implement the long-term planning, NASA naturally put a positive spin on their expectations beyond Apollo. Behind the scenes, however, there were growing misgivings over the rationale of such a plan, mainly through the lack of hard evidence that the Soviets were engaged in a race with America for the Moon at all. NASA was also concerned with protecting the funding for the mainline Apollo program, trying to create an optimistic but achievable program to follow the initial lunar landing from proven or developing hardware without threatening the entire budget. Then there were the outside influences over which NASA had no control, which were becoming far more urgent. Chief among these was the escalating conflict in South East Asia, which was rapidly draining funds from the national budget and costing American lives. Added to this was a growing uneasiness over the nuclear arms race and a collective disdain for the establishment, seen on university campuses across the country and in Europe. The astronauts and their families in Houston were not immune to this news and the prevailing mood across the nation, despite their commitment to reach the Moon, as many of their former colleagues were deployed in the conflict zones while the families they had known waited at home.

On March 24, the day after the release of the AAP schedule, MSC Director Robert Gilruth expressed his concerns about the long-term planning for AAP to George Mueller, the NASA Associate Administrator for Manned Spaceflight. Gilruth's main issue was that, with little prospect of increased funding, diverting the hardware originally intended to support the lunar landing effort to a new program would seriously threaten the primary goal of ensuring Apollo reached the Moon by 1970. His concern was justified. With the last of the Gemini missions planned for the end of 1966, and the inevitable secrecy surrounding a classified program such as MOL, Apollo remained the very visible primary program for taking American astronauts into space for at least the next decade, if not longer. In its current form, Apollo was also firmly committed to the dedicated launch site at the Kennedy Space Center (KSC) in Florida, where special facilities had been built at Launch Complex (LC) 39 for vehicle processing, transportation and launch, and dispatching missions to the Moon. Apart from the classified Vandenberg MOL facilities in California, there were no other suitable American launch sites available, nor funds in place to build new ones. Even the original plans for four Saturn V-class launch pads at LC 39 had been reduced to just two, supported by a pair of Saturn 1B launch complexes designated LC 34 and 37.

With all the Apollo hardware designed and planned for launches from the expensive facilities in Florida, inserting *any* mission which was not targeted at the Moon would be challenging, especially when the rate of Moon missions increased as the momentum of the Apollo lunar effort towards Kennedy's goal gathered pace. Even when alternative plans were reviewed, such as delaying the Orbital Workshops until the early 1970s, Gilruth still noted a serious mismatch between the projected plan for AAP, the opportunity to achieve it and the resources to support it. As the Group 5 astronauts began their academic training at NASA in the summer of 1966, there were already warning signs that they might have a very long wait for a flight; early indications of an uncertain future for the program. Those early indications gradually became reality for the astronauts and the space agency over the next four years, as events at home and abroad had a far-reaching effect across America, even into the hallowed halls of the Astronaut Office.

OBSERVING GEMINI

Though selected to fly on Apollo-class spacecraft, the new astronauts had arrived in Houston during the middle of the second year of Gemini flight operations. That program had been created as a bridge between the one-man Mercury and the far more advanced three-man Apollo missions. The primary objective for Gemini was to provide valuable flight and operational experience in key techniques associated with ensuring that Apollo would reach the Moon by 1970. These techniques were rendezvous and docking, extended duration spaceflights of up to two weeks, spacewalking (EVA, or Extra Vehicular Activity), and pinpoint recovery. In addition, by flying an incredible ten manned missions in less than two years, Gemini would provide much needed operational experience of regular launch processing, prolonged shift work in Mission Control, worldwide tracking and ocean recovery operations. On the human side, those ten manned missions provided invaluable experience, from habitation in a small confined spacecraft, to new levels of training and mission preparation for the crews, those who trained them, and the mission planners. Without the contribution of Gemini, it is difficult to see how the Americans would have been able to leap from the limited capabilities of Project Mercury to the sophistication of Apollo and still gain the experience and confidence to land on the Moon by 1969.

For the 19 who were selected from the 44 finalists in Houston in February 1966, their casual acquaintance with the five Gemini missions flown in 1965 suddenly took on more personal relevance when the Gemini 9 prime crew of Elliot See and Charles Bassett were killed later that month. They died when the T-38 they were attempting to land in poor weather clipped the roof of the McDonnell building in St. Louis that housed their spacecraft and crashed. It was a somber reminder of the dangers that were still present, even if they were not in the combat zone of Vietnam. The following month, barely a fortnight before the 19 were publicly named as NASA's new astronauts, the Gemini 8 crew of Neil Armstrong and Dave Scott experienced in-flight problems with their spacecraft shortly after achieving the world's first docking with the Agena 8 unmanned target. Procedures called upon to regain control of their tumbling spacecraft triggered mission rules to abort their mission early and come home, just ten hours into a planned three-day mission. The dramatic events of that shortened mission would certainly have been closely scrutinized by the '19' as they prepared to embark on their own space adventures.

A little over a month after the Group 5 astronauts arrived in Houston, the Gemini 9 flight became the first mission to fly *after* they had joined NASA. With the original backup crew of Tom Stafford and Gene Cernan taking the places of their fallen colleagues See and Bassett, not only was this mission emotionally charged for the two astronauts flying the mission, but the flight also had its own share of problems, once again revealing just how difficult spaceflight could be.

On May 17, the original unmanned target vehicle for the Gemini 9 mission fell into the Atlantic after a second stage malfunction. On June 1, the launch of the Gemini spacecraft was abandoned due to computer problems after a replacement target, the Augmented Target Docking Adapter (ATDA), had been orbited. Finally, on June 3, Gemini 9 lifted off the launch pad. Most of the new astronaut group were busy completing a geological field trip to the Grand Canyon in Arizona at the time, only catching up on the latest news and how difficult it had been to get Gemini 9 off the ground upon their return to Houston. Meanwhile, Stafford and Cernan had guided Gemini 9 close to the ATDA but, much to the crew's frustration, were unable to dock with it. This was due to the launch shroud still being partially attached and gaping "like an angry alligator," as the astronauts described their orbiting target vehicle. Setting their disappointment behind them, the crew then began preparations for an EVA, but were again thwarted when Cernan found trying to control his actions in weightlessness exhausting. It began by experiencing poor communications with Stafford in Gemini and battling with a snaking umbilical tether. On top of this, the spacesuit's environmental control system was unable to cope with the added exertion, causing the faceplate of Cernan's helmet to fog up and severely restrict his vision. Although he managed to don his back-mounted Astronaut Maneuvering Unit (AMU) at the rear of the spacecraft, the planned flight evaluation was called off due to the various difficulties encountered, which could easily have cost the overheated Cernan his life. New recruit Ed Givens was paying close attention to Cernan's struggles, having been involved in developing the AMU unit for the USAF who intended employing it in the MOL program. Cernan's near-calamitous spacewalking exploits gave further insight into the complexities of preparing for and executing a spacewalk, a task which Ed White had made to look so effortless a year before on Gemini 4, but which Dave Scott had been unable to perform on Gemini 8.

The following month saw the launch of Gemini 10, carrying astronauts John Young and Mike Collins on a three-day rendezvous and docking mission with two different target vehicles. The docking went well with their own Agena 10, as did a later rendezvous with the abandoned Agena 8, but as Collins conducted the EVA activities he was also thwarted in his efforts, by insufficient restraints and a troublesome environmental control system.

Breakfast with the GT-11 crew. (Left, from front): GT-11 Pilot Dick Gordon, Carr, Brand, Mattingly. (Right, from front): GT-11 Command Pilot Pete Conrad, Evans, Haise and Bull. (Courtesy Ed Hengeveld)

In September 1966, six of the new astronauts journeyed to the Cape to witness the launch of Gemini 11, the penultimate mission of the two-man series. On the morning of September 10, the day scheduled to begin this latest space mission, Vance Brand, John Bull, Jerry Carr, Ron Evans, Fred Haise, and TK Mattingly had breakfast with the Gemini 11 prime crew of Pete Conrad and Dick Gordon. But there was no launch. A malfunction in the Atlas launch vehicle that carried the Gemini 11 Agena target vehicle caused the launch to be cancelled and delayed by two days. The visiting astronauts, disappointed at not seeing a manned launch up close, had to return to Houston that day in time to begin their first sessions of CSM Systems training, scheduled for September 12. On the first day of their course back in Houston, Gemini 11 launched successfully within 94 minutes (or one orbit) of the Agena 11 target vehicle. The CSM procedure simulated the LM taking off from the lunar surface and its subsequent rendezvous and docking with a CSM in orbit around the Moon, something the Group 5 astronauts paid close attention to, as each of them was hoping to repeat the process themselves for real in the near future.

Following their successful docking with the Agena, the Gemini 11 astronauts prepared for their own EVA program. Unfortunately, Dick Gordon encountered further difficulties when his spacesuit's life support system failed to cope with his exertions as he tried, without suitable restraint devices or footholds, to attach a tether to the docked Agena. Though he did eventually succeed, his efforts exhausted him and forced the EVA to be terminated after only 38 minutes. A new idea being developed at the time was to use underwater simulation as a training method for EVA, and this innovation was being investigated to support the final Gemini mission to help understand how to overcome the many challenges of EVA. Meanwhile, on Gemini 11, Conrad and Gordon used the Agena's engine to boost their orbit to a record apogee of 497 miles (800 km). The next time astronauts planned to be that far from Earth would be when an Apollo crew took a CSM and LM for a deep space test, to an apogee of 4,000 miles (6,437 km). In fact, it proved to a be much longer wait, towards a more challenging target some 240,000 miles (386,243 km) away, over a Christmas holiday season. That spectacular event would involve several of the new astronauts in key supporting roles. [1]

First CB technical assignments

A little over two weeks later, on October 3, 1966, Chief Astronaut Alan Shepard issued a memo informing the new group of their initial technical assignments in the various CB Branch Offices. The Astronaut Office handled the management and organization of the astronaut team and, in addition to crews in training, was divided into various branch offices so that several astronauts could focus on key areas across multiple projects or programs. These technical assignments would run concurrently with the new astronauts' academic and proficiency training. [2] In his reorganization, Shepard divided the 19 men across six branch offices, which mainly focused upon the Apollo-related hardware in which they were expecting to fly.

Heading up the *Apollo Applications Branch* was Branch Chief Alan Bean. He, and fellow Group 3 astronaut Bill Anders, were joined by Joe Engle, Jack Lousma, Bill Pogue and PJ Weitz from the new intake. After recently completing his Gemini 11 assignment, Pete Conrad headed up the *CSM Block II Branch*, assisted by his former Gemini 11 pilot Dick Gordon. They were now joined by Vance Brand, Ron Evans, TK Mattingly, Jack Swigert and Al Worden. The *LM/LLRV/LLRF Branch* was headed by Neil Armstrong, whose group included John Bull, Jerry Carr, Fred Haise, Jim Irwin and Ed Mitchell.

Thanks to his previous experience on the USAF AMU device, Ed Givens was the only Group 5 member assigned to the *Pressure Suits/PLSS and Recovery Branch*, which was headed by John Young, assisted by Group 4 scientist astronaut Joe Kerwin. Another scientist astronaut, Owen Garriott, became the Chief of the *Experiments Branch*, which included his Group 4 colleagues, Ed Gibson, Curt Michel and Jack Schmitt and was expanded by the arrival of Group 5 members Don Lind and Bruce McCandless.

Finally, Charlie Duke and Stu Roosa joined the *Boosters/Flight Safety Panels Branch*, which was initially headed by Frank Borman but was now led by C.C. Williams. Roosa was also given a second technical responsibility, for celestial navigation. As members of the 'Boosters' branch, Duke and Roosa had to spend a significant amount of their time at the Marshall Space Flight Center (MSFC) in Huntsville, Alabama, where the Saturn family of rockets had been under development since the late 1950s. They also journeyed out to the nearby Michoud Test Facility near Gainesville, Mississippi, where the first and second stage engines of the huge rocket were being test-fired. Both astronauts were initially disappointed with the assignment, believing they had been given a dead-end job while their colleagues became more familiar with the CSM and LM. Despite feeling that they had 'missed the party,' however, both men subsequently found the assignment very interesting, as they attended meetings with Saturn creator Wernher von Braun, witnessed test firings of the huge rocket engines designed to power the launch vehicles, and reported progress back to other members of the Astronaut Office.

One of the initial live mission assignments for a Group 5 astronaut came in September 1966, when Charlie Duke was assigned as 'Booster' for the launch of Gemini 11. As a member of the Mission Control team 'on console,' monitoring the Titan II launch vehicle during ascent, this position entailed monitoring pressure and temperature readings from the onboard propellants and being prepared to respond if things went wrong. Fortunately, it was a textbook launch, which gave Duke the tremendous thrill of being part of a team working on an actual mission. The excitement of being aware of real time data and events as a mission was in progress made a lasting impression on Duke, on the first of what became several tours of duty in Mission Control for him over the next decade. Recalling his early work on Gemini, Duke explained that he "assisted in the simulations that went into flight training, got to meet a lot of the flight control team and then, at lift off, was part of the team in Mission Control… Even though my job was over in the first ten minutes of flight, it gave me a feel for Mission Control and appreciation of the important job those dedicated engineers performed. I remember, I got very tense as I sat there, listening to the countdown for the lift off… and imagined how the crew must be feeling." [3] Two months later, he was back on duty again, this time as 'Booster' for the final flight in the series, Gemini 12.

Additional collateral duties

With the growing complexity of both Apollo and AAP missions, it was decided between the Astronaut Office and the various directorates and branch offices at MSC to join the new group together with the 1965 Group 4 scientist astronauts administratively, and have them specialize in different facets of Project Apollo and AAP as both programs would use Apollo hardware. Shortly after receiving their first briefings on the spacecraft hardware, it was also decided to split the '19' into three groups (CSM, LM and Boosters). This would ensure that by the time the first manned missions of Apollo started flying in 1967, each of them would be ready to take on support roles prior to their own flights. They were asked which option they preferred to specialize in – either the CSM or the LM – but the final decision, as ever, remained with Deke Slayton. Some of the astronauts also had dual assignments, supporting developments in the AAP Branch Office. This early division of the group, to what was termed 'Collateral Duty assignments,' would have an influence on their future assignments; either to orbit the Moon in a CSM, be a member of a lunar landing crew flying the LM and step into history by walking on the Moon, or being identified for later assignment under AAP. The division of the Group 5 astronauts was:

- *CSM Group*: Brand, Evans, Givens, Mattingly, Pogue, Swigert, Weitz and Worden (and later Roosa). This group would work closely with North American Aviation in Downey, California, the prime contractors of the CSM.

- *LM Group*: Bull, Carr, Engle, Haise, Irwin, Lind, McCandless and Mitchell (and later Duke and Lousma). Representatives from this group would regularly visit Grumman, the primary contractor for the LM in Bethpage, New York. Fred Haise in particular would spend a considerable amount of time at Bethpage, assisting in the development of the LM.

Six days in a can

Another direct involvement in Apollo hardware testing for the new astronauts began less than six months after joining the Office. On October 26, 1966, Ed Givens, scientist astronaut Joe Kerwin and aerospace technologist Joseph A. Gagliano, clambered into the Command Module (CM) of Spacecraft 008 for a six-day systems test. The objective of the test was to demonstrate that the performance of the Block I Environmental Control System (ECS) was compatible with the other systems, in modes duplicating those planned for the Apollo 1 (AS-204) mission the following February. The complete spacecraft, including the Service Module (SM), was located in the large 65 ft. (19.8 m) by 117 ft. (35.6 m) Chamber A of the Space Environmental Simulation facility at MSC. The test ended on November 1 and the 'crew' were reported in good physical and psychological condition. Having met all the pre-test requirements, the spacecraft's systems performed 'satisfactorily' and once the medical checks were completed, the trio then completed several engineering and operational debriefings, providing baseline information to help refine the flight plan being developed for Apollo 1. [4] The simulation revealed several design flaws and procedural errors. These could now be rectified in time for the first actual manned lunar mission.

The last Gemini standing

Ten days after the Apollo test ended, the final Gemini mission, GT-12, left the launch pad, completing a remarkable program of ten manned missions in just 20 months and successfully demonstrating the range of techniques critical to Apollo. Gemini had verified the concepts upon which Apollo could progress to the Earth orbital flights of the Block I CSM in early 1967. But while NASA moved on to Apollo, Gemini still had a role to play, as the intended crew transport vehicle for the USAF MOL astronauts. The refurbished Gemini 2 spacecraft was used for the first unmanned launch – and what would turn out to be the *only* launch – within the MOL program. While the USAF astronauts monitored the flight and the integrity of the heat shield hatch added to the Gemini design – through which they would gain access to and from the laboratory – members of NASA's Group 5 astronauts were observing the progress of the final Gemini mission, which would clear the way for Apollo and, in time, their own entry into space.

On Veterans Day, November 11, 1966, as Charles Duke was once again sitting at the Booster console in MCC Houston, his friend Stu Roosa was at the Cape. He was assigned to the launch of Gemini 12 as Capsule Communicator (Capcom, a position also called 'Stony') in the Blockhouse near Pad 19, communicating with the crew in the final stages of the countdown. While Roosa found himself in a key position for the start of the mission, seven of his colleagues – Brand, Evans, Lind, McCandless, Pogue, Swigert and

Worden – had been even closer to the prime crew on that day, as they had joined Jim Lovell and Buzz Aldrin, plus Chief Astronaut Al Shepard and Group 4 scientist astronauts Owen Garriott and Ed Gibson, for the traditional pre-launch breakfast.

EARLY ASTRONAUT OFFICE APOLLO APPLICATIONS ACTIVITIES

In addition to the mainline Apollo, the new astronauts were also involved in the early stages of the planned follow-on, AAP, which included a range of scientific Earth-orbital missions, and eventually – it was hoped – expanded lunar activities. The centerpiece of the program was a series of Orbital Workshops (OWS) which, in these initial plans, would be created by using the spent (empty of fuel) S-IVB stage of a Saturn launch vehicle, fitted out on orbit. These rudimentary 'space stations' were designed to host at least a trio of three-man crews, arriving via Apollo CSMs for durations of 28, 56 and 56 days. As the series continued, longer expeditions of between four and six months were planned. With such complex missions to prepare for, in parallel but secondary to the lunar missions, the management of the Flight Crew Operations Directorate (FCOD, headed by Deke Slayton) and the Astronaut Office (with Chief Astronaut Al Shepard) required astronauts to be assigned early to fulfill the Office role in developing the hardware and procedures. In these formative years, the AAP program walked a fine line between diverting attention and funds from the mainline Apollo and maintaining confidence that the long-term program was a real possibility, with no assurances from Washington that any AAP mission would even be funded, let alone fly.

The origins of the AAP office date back to August 6, 1964, when Group 3 astronaut Rusty Schweickart's technical assignment became "future programs and inflight experiments," while Walt Cunningham was assigned to "non-flight experiments." As Cunningham explained to the authors, "During 1964 and 1965, AAP was not even a glint in anyone's eye at the Office at the time." It was only after the first six scientist astronauts came on board on June 28, 1965, that the Astronaut Office really got into the AAP missions.

From July 29, four of the six new scientist astronauts were required to undertake a 53-week jet pilot training course. The remaining two members of that group (Joe Kerwin and Curt Michel), who were already jet qualified from their previous military service, were given technical assignments for a year. Kerwin went to work on pressure suits and EVA, while Michel was assigned to Experiments and Future Programs, replacing Schweickart who was to join Jim McDivitt's as yet unannounced Apollo crew with Dave Scott. The following month, what had been called the Apollo Extension System (or Apollo X) under the Future Programs Branch, was given its own program 'Office' at MSC and renamed Apollo Applications. [5]

Another memo from Al Shepard, dated February 3, 1966, explained the establishment within the Astronaut Office of a new Advanced Programs Branch Office, which would handle AAP issues relating to the Astronaut Office. The first Chief of the AAP Branch was former Mercury astronaut Scott Carpenter, assisted by Kerwin and Michel. The plan was that once the other three scientist astronauts (Garriott, Gibson and Schmitt) had completed flight training in September, they would also be assigned to this office.

During the summer, however, as the end of the Gemini program approached, Shepard reviewed the structure of the Astronaut Office, now expanded with 19 new members. In October, he renamed the Advanced Program Branch, which now became the Apollo Applications Branch, and assigned Alan Bean as Branch Chief. At the same time, Shepard established an Experiments Branch, assigning Owen Garriott as its Branch Chief. Shepard's memo of October 3 then outlined the assignment of Engle, Lousma, Pogue and Weitz to their collateral duties in the AAP Office, and Lind and McCandless in the Experiments Branch. In a further memo, issued two months later on December 5, Ed Givens was also identified under the AAP Branch Office, with responsibilities for pressure suits.

The demise of Apollo 2

Though the prime and backup crews for Apollo 2 had been in training since the beginning of the year, they were not officially announced until September 29, over eight months later. The delay was mainly due to difficulties in qualifying the flight hardware for both the first and second missions. In the background, though, there was a clear lack of enthusiasm over the second mission from the prime crew commander, Walter Schirra, who viewed it as a duplication of the first mission's objectives. There would be as many as 15 science experiments added to a busy program of important engineering tasks on the new spacecraft for the two-week mission. By the middle of September, both the prime and backup crews for Apollo 1 and 2 had discussed the problems they had encountered in preparing for their missions, which resulted in a two-page list of 16 items they thought were imperative to streamline preparations for the missions and prioritize the tasks to be accomplished. Clearly, they were not happy with things as they stood. The crews would receive even more disappointing news on October 25, after the SM assigned to the second mission suffered an explosion during a routine ground test. Though the problem was quickly identified and corrected, the number of Block I SMs available was limited, meaning the replacement would have to be a Block II SM. This was found to be incompatible with the Block I CM and posed a problem that was quickly and quietly resolved by NASA management, who simply cancelled the duplicate Apollo 2 mission and moved the Block I experienced prime crew to back up the Apollo 1 crew of Grissom, White and Chaffee. NASA would progress directly to the Block II missions after only a single flight. With little warning, Schirra's crew was informed on November 15 that their Apollo 2 mission had been cancelled. The formal announcement came two days later, also revealing that the original backup crew of Apollo 1 (McDivitt, Scott and Schweickart) would fly the new Block II Apollo 2, featuring the first manned test of the Apollo LM in Earth orbit. [6]

Nomenclature of Apollo crew designations

The final Gemini mission came home on November 16, right in the middle of the changes to Apollo 2. Less than two weeks later, Deke Slayton issued one of his own memos, dated November 29, 1966, identifying new crew designations for the advanced Apollo Block II missions in which the Group 5 astronauts were eventually hoping to fly. The former nomenclature of *Command Pilot, Senior Pilot* and *Pilot* was perfectly adequate for the

Block I mission of Apollo 1 (and the originally envisaged Block I Apollo 2), but, as Slayton explained, "a more descriptive designation is desirable for Block II flights [including the revised Apollo 2 mission]. Therefore, the following designations and positions are intended to be used on all mainline Block II flights." [7]

- *Commander:* Formerly the *Command Pilot*, and now abbreviated to CDR. In the CM, they would occupy the left seat for launch and the center seat option for the remainder of the mission, while in the LM, the CDR would occupy the left seat[1]. Primary responsibilities for the CDR were listed as overall command of the mission, monitoring the booster (launch vehicle) during the ascent to orbit, and being in command of the LM for descent and landing, for the surface operations, for ascent and rendezvous with the CSM and for LM guidance and navigation.
- *Command and Service Module Pilot:* Formerly the *Senior Pilot* and now abbreviated to CM Pilot or CMP. Occupying the center seat for launch and left seat option for the remainder of the mission, CMP responsibilities were listed as being second in command of the mission and responsible for CSM guidance and navigation, with primary responsibility for transposition of the CSM from the S-IVB upper stage and docking with the LM, and for trans-lunar injection burn and mid-course corrections. The CMP would be in command of the CSM during the lunar orbit phase and hold detailed knowledge of its systems. They would also be responsible for the retrieval of a malfunctioning LM, for the trans-Earth injection and mid-course corrections, and for Earth reentry and landing.
- *Lunar Module Pilot:* Formerly the *Pilot* and now abbreviated to LM Pilot or LMP. The LMP would occupy the right seat in the CM and right seat (flight position) in the LM. Originally, the lunar lander was called the Lunar Excursion Module (or LEM), but in time, NASA found 'Excursion' too frivolous and dropped it from the designation, while retaining the phonetic 'LEM' identifier. The LMP would have an operating knowledge of the CSM systems and detailed knowledge of the LM systems, be responsible for the LM guidance and navigation, serve as backup to the commander for LM descent and landing, and hold responsibilities for lunar surface operations. They would have primary responsibility for lunar experiments and serve as backup for the LM ascent and rendezvous phases of the flight.

Slayton's memo concluded with the statement that, "On AAP missions, the LM Pilot will be designated Mission Module Pilot (MMP). Responsibilities will be designated when mission plans evolve." The first AAP 'missions' were still some years away (in fact over six) and when they did become more prominent in mission planning, the role of MMP became Science Pilot (ScPLT) on Skylab, and Docking Module Pilot (DMP) for Apollo Soyuz, ironically a position filled by Slayton himself on his only spaceflight.

Due to the complexity of each mission, it was natural to assume that the CDR, certainly on the early missions, would be a flight experienced, veteran astronaut. The early CMPs also had to be senior, recently flown astronauts, due to the requirement for rendezvous and

---

[1] Slayton wrote metaphorically here, as seats had been removed from earlier designs of the LM to save weight. Referring to a pilot's understanding of an aircraft flight deck, he meant the left-hand flight position.

docking experience and competence in flying the CSM alone in lunar orbit[2]. It was thought that once a CMP flew, they would progress to a subsequent flight, initially as backup, then three flights later as prime CDR. The LMPs (who never actually 'piloted' the LM, as this remained the role of the CDR) were normally the rookies on a crew, but they would have the ultimate reward on landing crews of the opportunity to walk on the Moon.

Deke Slayton had introduced a crew rotation system for Gemini to capitalize on training and experience, where an astronaut serving as backup for one mission would skip the next two to allow time to train for a new mission and fly as prime on the fourth. He introduced a similar system for Apollo. In theory, this meant that the crew assigned to backup duties on, for example, Apollo 12, would be subsequently named as the prime crew for Apollo 15. This system worked very well and was continued through to the end of the Apollo program.

All change on Apollo

With the launch manifest for the first three manned Apollo missions reshuffled, there would inevitably be an impact on crewing assignments. As these missions were becoming increasingly complex, Slayton recognized that having a third tier of 'crewing,' known as the support crew, would be beneficial for the prime and backup crews. This practice would be continued for all crew assignments through to ASTP in 1975. Support crews were assigned partly in response to Office concerns that the contractors for Apollo were spread across the United States, in particular the contractors for the two main spacecraft (the CSM and the LM), who were located on opposite sides of the country. It was found that crew representation was being lost at key meetings and important points in hardware development. The Office desired a voice in these meetings and having the support crew present, as specialists in either the CSM or LM, would be beneficial. Members of the new fifth astronaut class took on most of these responsibilities in the early days. The support crew would also alleviate the involvement of the prime and backup crew in some of the more mundane tasks requiring the presence and input of a qualified astronaut. Slayton therefore decided, with the recent changes to the first three Apollo missions, that he would assign at least a trio of Group 5 astronauts in support of the main crews.

According to the notes in the Curt Michel files at Rice University, this was discussed at the pilots' briefing on December 5, 1966. At that meeting, Michel made handwritten notes on the changes that were to be announced to the crewing (CDR/CMP/LMP) of early Apollo missions. [8] These assignments were:

- AS-204 – Apollo 1, Prime Crew of Grissom/White/Chaffee with backups Schirra/Eisele/Cunningham. This crew would be flying the only Block I CSM in Earth orbit, on a 14-day open-ended mission launched by Saturn 1B.
- AS-258 – Apollo 2, Prime Crew of McDivitt/Scott/Schweickart with backups Stafford/Young/Cernan. This mission involved two launches: firstly AS-205, with the first manned Block II CSM launched on a Saturn 1B; secondly AS-208, which

[2] This changed in 1970, when rookie Group 5 astronauts were assigned to the CMP seat from Apollo 13 through Apollo 17, and for both Skylab and ASTP.

would launch the initially unmanned LM (also on a Saturn 1B) into Earth orbit. This mission would involve rendezvous and docking between the two spacecraft and a series of manned tests of the free-flying LM, before rendezvous and docking practice with the CSM. There was also a plan to perform the first EVA from Apollo to evaluate the pressure garment intended to be worn on the Moon. This EVA would also be an opportunity to simulate a contingency EVA transfer back to the CSM, in the event of a failed or faulty docking system preventing the use of the internal tunnel transfer between the two spacecraft. In his notes, Michel had hand-written the observation that AS-205 was no longer the 'official' designation of the mission, which had now blended the -205 and -208 designation to become AS-258
- AS-503 – Apollo 3, Prime Crew of Borman/Collins/Anders with backups Conrad/Gordon/Williams. This Block II CSM mission would further evaluate dual flight operations with the LM, but this time both would be launched on a single launch vehicle. Therefore, this mission was planned as the first manned flight of the Saturn V.

At the same meeting, Michel noted the names of almost half of the fifth group, who had been assigned to the first Astronaut Support Crews:

- Apollo 1: Givens, Evans and Swigert (all specialists in CSM systems and procedures).
- Apollo 2: Haise, Mitchell (both LM specialists) and Worden (CSM Specialist).
- Apollo 3: Bull, Carr (both LM specialists) and Mattingly (CSM Specialist).

In his notes, Michel added the name in brackets of Jack Swigert with a question mark, indicating that his assignment at that point had still to be confirmed. It was a logical decision to assign three CSM specialists to the first manned Apollo mission, as this was planned as a CSM-only flight. The introduction of the LM from Apollo 2 necessitated the first pair of LM specialists assigned in a support role, and was repeated for Apollo 3.

During the same meeting, and reflecting the changing makeup of the Astronaut Office, amendments to the technical assignments in the office were also identified:

- *Block II CSM*: Conrad (Branch Chief), with Gordon, Brand, Evans, Mattingly, Swigert and Worden.
- *AAP:* Bean (Branch Chief), with Anders, Engle, Lousma, Pogue and Weitz.
- *LM/LLRV:* Armstrong (Branch Chief), with Bull, Carr, Haise, Irwin, and Mitchell.
- *Suit/PLSS/Recovery:* Young (Branch Chief), with Kerwin and Givens.
- *Experiments:* Garriott (Branch Chief), with Gibson, Lind, McCandless, Michel, and Schmitt.
- *Boosters/Flight Safety:* Williams (Branch Chief), with Duke and Roosa.
- *Water Tank/Zero G:* Carpenter (Branch Chief).

The new crews for the first three missions were officially announced on December 22. Another handwritten note from Michel, undated but either late 1966 early 1967, showed further adjustments to the structure of the CB:

- *AAP:* Bean (Chief), with Engle, Kerwin, Lousma, Michel, Pogue and Weitz.
- *CM (Block II):* Lovell (Chief), with Buzz Aldrin, Brand and Evans.

- *LM (LLRV):* Armstrong (Chief), with Bull, Carr, Irwin and Mitchell.
- *Suits:* Givens (Chief), with Kerwin.
- *Experiments:* Michel simply wrote 'same', which probably meant Garriott (Chief), with Gibson, Lind, McCandless, Michel and Schmitt.

A bug in the (vacuum) system

In his 1973 memoir, Jim Irwin noted that in the closing weeks of 1966, Neil Armstrong, then Chief of the LM Branch, had assigned him to work with John Bull on the LM thermal vacuum test program using Lunar Test Article-8 (LTA), starting in the New Year. These tests were designed to qualify the design and systems of the lunar lander for operational manned spaceflights and thereafter for the first lunar landings. This was an important assignment for Irwin and Bull this early in their NASA careers.

Six months in Houston.

By the end of the year, the Class of '66 had been at NASA for over six months and were approximately halfway through their academic and general training program. They had also received their first technical assignments and begun specializing in either the Apollo CSM, LM or launch vehicles, with a few having experienced operational missions in Gemini and support roles on three Apollo crews. It was expected that the first Apollo missions would be flying early in 1967 and that progress on both the lunar missions and with AAP could see further announcements of support assignments later that year.

The Christmas holidays of 1966 were a time of reflection for each of the now not-so-new astronauts on how far they had come in the twelve months since the deadline for submitting their applications to NASA. So much had changed and they had already learned a great deal, but there still remained much more to do and to absorb. They all realized how challenging 1967 would be, though the way the year turned out was not how any of them had expected.

FIRE IN THE SPACECRAFT

Just nine months after his selection by NASA, Stuart Roosa would come to learn the grim reality attached to being an astronaut. On Friday, January 27, 1967, he was serving at the Capcom console in the pad blockhouse during the troubled 'plugs out' test for the Apollo 1 crew, seated right next to Deke Slayton, the Director of Flight Crew Operations.

From inside the sealed spacecraft, Gus Grissom was complaining to Roosa about the poor communications system. Then, to everyone's shock and horror, a fierce fire suddenly erupted inside the CM, engulfing everything. It was fueled by the capsule's pure oxygen environment. Ashen-faced, Roosa frantically tried to contact the crew, but to no avail. In desperation, Slayton and Roosa bolted out of the blockhouse and ran to Pad 34, some 500 yards (457.2 m) away. But even as they reached the launch pad, ambulances were screeching to a halt at the base of the launch tower. They boarded the small elevator and rode up to level A-8, 218 ft. (66.44 m) up, heading across the swing arm to the clean room, which was a scene of panic. But it was too late; the three astronauts were all dead. After the hatches had been opened, Roosa was one of the first to view the charred interior of the once-pristine spacecraft and the bodies of his three astronaut colleagues. It was a tragic and sobering experience for the young pilot.

Recollections

The tragic events of January 27 continue to be a painful reminder, to all of those involved in the space program, of the dangers facing crews even during training. Perhaps most difficult to accept was the fact that the accident occurred not in space, but on the ground. For the 19 new astronauts, just over seven months into their training, it was a stark reminder of the dangerous profession they were in, with the news of the accident being received as they continued their assignments across the country.

On the morning of the Apollo 1 fire, Jim Irwin was flying from Long Island, New York, to San Jose for a family gathering when he heard about the fire over his T-38 radio just before he landed. Still in shock, he and his wife Mary flew to Houston the next day.

Ron Evans was on a support crew for the Apollo 1 mission, as his wife Jan later recalled: "In fact, he'd been in that spacecraft running tests the afternoon before that fire." [9]

Ed Mitchell and Jerry Carr were among a small group of astronauts waiting for their commercial flight at LAX airport, California, having been on a familiarization visit to North American Rockwell, makers of the Apollo spacecraft. They heard a grim television report that there had been a fire on a launch pad at the Cape and three astronauts were believed to have been killed. Carr was desperate to find out more. "We had no other information. A bunch of us were just kind of wandering around [saying], 'How can we find out what happened?' I said, 'I'm just going to call the *Los Angeles Times* and ask them.' So I did. I picked up the phone and called the *L.A. Times* and told them who I was, and I said, 'We've just learned about this. We don't have any information. What can you tell us so that we'll have some knowledge as we go back home?' And so they gave me the information and I passed it on to the rest of the guys." [10] Then Mitchell was paged over the intercom, and when he got to the phone Deke Slayton was on the line. He confirmed the bad news that the three astronauts were dead.

Al Worden was still at the North American plant in Downey, California. He was looking forward to flying home for the weekend when he also received an urgent phone call from Deke Slayton. "There had been a fire inside the spacecraft at the Cape, he told me, and all of the crewmembers were dead. Stafford, Young, Cernan needed to get out of the near-identical spacecraft at Downey, and all further testing was cancelled." [11]

Vance Brand was on a public relations trip to northern Texas, attending a dinner at the Fort Worth Hotel with film actor and Medal of Honor winner Audie Murphy and Congressman Olin E. 'Tiger' Teague (Democrat, Texas). Teague was the Chair of a House committee with NASA oversight and received the news of the accident via a telephone call. "The devastating announcement broke up the dinner and I hurried to Naval Air Station Dallas, jumped into my airplane and departed for Houston," Brand later recalled. [12] During the recovery following the fire, Brand and many of his colleagues assumed additional duties supporting various investigations. "I was an Astronaut Office representative monitoring ground testing of spacecraft cabin materials at MSC and replacement of flammable materials in the cabin of the Apollo Command Module," for which Brand spent a considerable amount of time at NAA in Downey, California.

For Charlie Duke the 'terrible' news came in the middle of his acceptance speech in his hometown of Lancaster, for receiving the 'Lancaster Jaycees Young Man of the Year Award.' He was called away from the microphone, as he recalled in 1990; "It's hard to describe the shock and sense of loss which I experienced at this point. It was almost with tears that I walked back to the meeting, choked up and hardly able to talk, and announced the death of three friends" [13] Subsequently, both Duke and Roosa were assigned as astronaut representatives on the Emergency [Pad] Egress Working Group.

The news of the tragedy soon reached the MOL astronauts, as Bob Crippen recalled: "All the MOL guys were at a going away party for Gen. Bernard Schriever who was retiring. He was an important person in selling the MOL program. The news of the Apollo 1 fire went through the room like a fire itself. It was shocking to us all, but not on a personal level. I didn't know the crew. The Apollo Command Module was not our vehicle since were flying the Gemini. However, we knew it wasn't good news for any manned space program." [14]

Poignant changes

Despite the loss of their colleagues, all of NASA's astronauts released that, pending the investigation and inquiry into the accident, the program would still go on. As Gus Grissom himself once stated, in response to a question on the risks of spaceflight: "If we die, we want people to accept it. We're in a risky business, and we hope that if anything happens to us it will not delay the program. The conquest of space is worth the risk of life." Critical changes would have to be made of course, not only to the hardware and procedures, but also in the crewing for future missions.

What could not have been foretold was how tragic the year of 1967 would become, both for the fraternity of NASA's fifth astronaut group and for the USAF MOL team. One early decision taken was that the first Block I spacecraft would not fly with a crew aboard. Once the accident had been fully reviewed, its lessons learned, and changes implemented, the mission planners would progress straight to Block II CSM operations.

At the start of the year, on January 6, 1967, Chief Astronaut Alan Shepard had issued another memo reviewing technical assignments within the Astronaut Office, updating the one he had issued the previous October. Shortly after the loss of the Apollo 1 crew, there was another meeting to outline the changes in the office resulting from the tragic accident. This must have been a very difficult meeting for them all, and from the hand-written amendments by Curt Michel, a poignant moment in time, when the loss of their colleagues must have felt very raw throughout the Astronaut Office. Shepard's new memo deleted the names of the Apollo 1 prime crew and replaced them with the backup crew of Schirra, Eisele and Cunningham. In this way, they were formally assigned to the new, still unofficial, maiden Apollo manned mission. As hard as this period was, it remained imperative to continue to probe into what had caused the horrifying deaths of Grissom and his crew, and to prepare for the resumption of flights. Moving the backup crew to the prime position would mean that their months of training for a CSM-only flight would not be wasted. This move, in turn, created the need for a new backup crew, so two formerly named backup teams each moved up one mission, once again capitalizing on the training already accomplished. In the new sequence, the replacement backup crew for the first mission (which eventually became Apollo 7) were identified as Stafford, Young and Cernan, who had previously backed up McDivitt's Apollo 2 crew. Replacing them on that flight were the backups for Borman's Apollo 3 crew, namely Conrad, Gordon and Williams. Slayton also brought in a new crew of Armstrong, Lovell and Aldrin, to replace the Conrad crew in the backup slot for Borman's mission.

Onwards, but not yet upwards

On February 4, 1967, the Apollo 1/AS-204 Review Board set up to investigate the cause of the fatal pad fire assigned all active astronauts as 'observers,' to assist members of the board and the investigation teams in gathering and analyzing information. As the weeks rolled by, the sorrow from the Apollo 1 tragedy remained, but the work had to continue if the Moon was to be reached by the end of the decade, and the loss of the crew would not be in vain.

In addition to developments progressing, albeit slowly, with the mainline Apollo lunar missions, work also continued in defining the role and scope of AAP, with members from the fifth group deeply involved in both programs. On April 4, 1967, a month prior to a walkthrough of the latest configuration of the S-IVB workshop, another memo was issued from the desk of Al Shepard to all astronauts, targeting the organization of the Office's Apollo Applications Branch with respect to projected AAP missions and programs. The memo stated that the former Experiment Branch would now be integrated into the AAP Branch. [15] The AAP office would therefore involve (with their review areas for the May S-IVB Workshop walkthrough review in brackets):

- Bean – Chief of Branch Office; scientist astronauts Garriott (communications), Gibson (crew quarters layout and controls), Kerwin (food, waste and IVA) and Michel (hand holds, tethers, foot rails); pilot astronauts Aldrin (*possibly* rendezvous, docking and EVA), Cernan (*possibly* rendezvous and docking and EVA), Engle (IVA equipment), Lousma (activation and deactivation), McCandless (Experiments AAP 1 and 2), Pogue (lighting and photography), Weitz (Experiments AAP 3 and AAP 4), with Lind and Schmitt. [16]

Cosmonaut tragedy

With Apollo grounded during the investigation into the pad fire, everyone was aware that the Soviets might take the lead in the race to the Moon until American astronauts returned to orbit. But following the fast pace of the early 1960s, things had slowed down considerably in the Soviet Union after the loss of the leading Chief Designer, Sergei Korolyov, in January 1966. He had been the main driving force behind their manned space program. Cosmonauts had not flown in space since March 1965 and in the intervening eighteen months, NASA had successfully flown the ten Gemini missions. Now, two years after the previous cosmonauts had flown in space, the Soviets were ready to man-rate their new spacecraft. Soyuz was far more advanced than Vostok, but had nowhere near the capabilities of Apollo.

For its ambitious maiden test flight, a rendezvous and docking was planned with a second Soyuz spacecraft, involving a partial crew transfer by means of a spacewalk. This would certainly grab the headlines, and the Soyuz 1 launch took place without incident on April 23, 1967, carrying sole cosmonaut Vladimir Komarov aloft. Once in orbit, however, one of the two solar power panels refused to deploy and the mission began to be plagued by attitude control problems, which could not be resolved. The spacecraft was also rapidly losing battery power. Reluctantly, ground controllers ordered Komarov to abandon his attempts to stabilize Soyuz 1 and prepare for an immediate return to Earth. The problems also led to the cancellation of plans to launch three more cosmonauts aboard Soyuz 2 (Valery Bykovsky, Alexei Yeliseyev and Yevgeny Khrunov) the following day. On April 24, Komarov initiated re-entry, which went as planned until the expected automatic deployment of his parachutes. The drogue chute was released, but a critical fault in the parachute container prevented the main chute from following. The reserve chute was then deployed, but it got tangled in the drogue chute and did not billow out. Komarov was killed when Soyuz 1 slammed into the ground at high speed and exploded. It was later discovered that the exact same fault existed in the parachute system aboard Soyuz 2. Had that crew launched the next day as scheduled, they would have suffered the same fate after re-entry, with catastrophic consequences for the Soviet space program.

As America mourned its three lost astronauts, the Soviets also now grieved over a fallen hero. The year 1967 was turning into a very bad one for human spaceflight and sadly, more was to follow.

New Office assignments

On May 9, 1967, less than four months after the Apollo pad fire, the names of the first manned Apollo crew (Apollo 7, later designated the C-Mission) were officially confirmed as Schirra, Eisele and Cunningham, with the backup crew identified as Stafford, Young and Cernan. [**17**]

Nine days later, another Shepard memo, dated May 18, revised assignments yet again, with immediate effect, starting with the support crew for Apollo 7 (CSM 101). Due to the nature of the mission, expected to be an eleven-day open-ended test flight of the Block II CSM in Earth orbit, a three-person support crew was, as Shepard put it, "assigned to the 101 crew as non-flight members." All three of them, Ron Evans, Ed Givens and Jack Swigert, were CSM specialists. The same memo named the revised point of contact for each branch:

- *Apollo mission operations and software* (Tom Stafford); *CM Hardware* (John Young); *LM Hardware* (C.C. Williams); *AAP* (Alan Bean); *Boosters* (Gordon Cooper); *USN Underwater/Zero G liaison* (Scott Carpenter)
- Group 5 assignments were also listed, with those named for thermal vacuum testing of the LM and CSM as: LM/LTA-8 Tests (Jim Irwin and John Bull); CSM/2TV-1 Tests: Vance Brand, who joined Buzz Aldrin (Group 3) and Joe Kerwin (Group 4). Charlie Duke and Stuart Roosa remained where they were and Ed Givens was still listed with technical assignments on Suits/PLSS along with Joe Kerwin.

Shepard managed the Astronaut Office firmly and his memos reflected his perceived persona of the 'icy commander,' rather than the 'smiling Al,' seen by the outside world. This put the new astronauts on their guard to ensure they did a good job. They quickly learned not to ruffle Shepard or Slayton's feathers, which might affect their chances of an early mission assignment. As Shepard noted in his May 18 memo, all astronauts were encouraged to "funnel information and decisions on matters not requiring my personal attention through these [points of contact] gentlemen. Only in this fashion can we achieve orderly flow of information and meaningful decisions." [**18**]

AAP BRANCH ASSIGNMENTS

While the recovery from the loss of the Apollo 1 astronauts significantly affected the lunar landing program, it also affected AAP. During this period, the organization of the Apollo Applications Branch evolved to reflect the recommendations from the AS-204 Inquiry and changes to the schedule. A typical example of the distribution of labor in the AAP Branch Office under the leadership of Al Bean reflects the long lead time required to develop a future program years before anything actually flew. The usual composition of the office during this period featured four sub divisions: Mission 1 & 2 (lead Al Bean); Mission 3 & 4 (lead Owen Garriott); Advanced Missions (lead Joe Engle); Future Programs Experiments (lead Owen Garriott).

- *Mission 1 & 2:* Under Operations & Training, Al Bean handled flight operations, training plans, simulator and mockup issues, while Jack Lousma worked on flight plan issues and Joe Kerwin looked after EVA/PCU/PLSS matters. Bean also worked on the controls and displays of the Airlock and Multiple Docking Adapter, while Lousma followed the sub-systems in those components. With regard to the S-IVB Workshop itself, Lousma held technical roles in the activation and shut down of the Workshop, and issues relating to the crew quarters, while Kerwin monitored developments in food and any waste issues, together with concerns over radiation levels. Lousma was also given responsibility in the Lunar Module & Survey System (LM&SS), controls, displays and systems. Bruce McCandless worked on experiments for the CSM, the Airlock and Workshop, and assisted in the electrical element of the 'cluster' (an early term for the combined Workshop/LM/SS/ATM/CSM configuration) systems and interfaces, along with Owen Garriott (communications) and PJ Weitz (mechanical/cryogenics/ECS).
- *Mission 3 & 4:* Development of the Operations and Training elements for these missions was handled by Owen Garriott (flight operations), Ed Gibson (flight plans), Bill Pogue (training plans and simulator and mockups) and Joe Engle (EVA/PCU/PLSS). Engle also handled the LM/ATM systems and, working with Gibson, the LM controls and displays. With the Workshop planned for continued use, issues concerning revisiting and resupplying the 'cluster' were the responsibilities of PJ Weitz, while Pogue handled issues relating to the crew quarters and Joe Kerwin continued his work in the areas of food, waste and radiation. Under Experiments, Curt Michel and Gibson looked after issues relating to the ATM controls and displays, while the CSM/AL/S-IVB experiments became the responsibility of Weitz.

Under Cluster Systems and Interface, Bruce McCandless handled electrical systems, Garriott looked after communications and Weitz was responsible for mechanical, cryogenics and ECS.

- *Advanced Missions:* As well as heading up the section, Joe Engle also handled issues related to planning future lunar landing missions under AAP and early satellite retrieval studies. Also in this department was Curt Michel, who followed developments in creating an advanced space station beyond the capabilities of the S-IVB cluster concepts.
- *Future Program Experiments:* In addition to heading up this section, Owen Garriott also handled issues regarding the development of experiment handling systems, under the contractor concept studies identified as AAP-A and AAP-B. Bruce McCandless was assigned to follow the development of experiments (thermo) relating to heat in space, involving generation, retention, protection and dissipation. Lunar Surface Operations under AAP was divided between Jack Schmitt and Don Lind. Both men were monitoring the development of the Apollo Lunar Surface Experiment Package (ALSEP), while Schmitt also focused upon geology during surface operations and Lind handled the field of physics.

Biographical or news release data regarding individual astronauts would show assignments such as these simply as 'assigned in the AAP Branch Office.' When examined in detail, however, there was always a lot more to an assignment than that basic headline. The challenge for the researcher is to dig a little deeper into those brief statements, and when possible, the fun comes from asking the individual to expand on the detail of exactly what they did, the experiences they encountered and what lessons were learned and shared with the rest of the office. Over time, it is possible to build up a broader picture of the work involved – sometimes years before hardware or missions are flown – and how the astronauts are an integral element of that development for flight.

Accident at MSC

Duties facing the astronauts were not always those prescribed by their training schedule. On May 26, 1967, Charlie Duke was keeping up his physical condition by working out in the astronaut gym, together with Al Bean and Rusty Schweickart, when they were alerted to a terrible accident nearby and hurried to help. Three employees of the Westheimer Rigging Company were injured when a crane hit a power line at the Space Center. The astronauts quickly gave artificial respiration and first aid for shock, before handing over to medical staff when they arrived on the scene and who would continue to tend to the men. Unfortunately, after more than an hour of medical treatment, Bert Beeler, 25, died from his injuries. The other two employees, E.C. Sanders, 59, and C.R. Tadlock, 58, were treated for their electrical burns then later released from hospital. [19]

Ed Givens

Barely two weeks after Duke's intervention in the industrial accident on site at MSC, one of his colleagues was involved in another incident, which had far more serious consequences. Ed Givens had elected to concentrate his training on the Apollo spacecraft's CM, believing he would first fly to the Moon as a CMP, then later switch his training to become a LMP and land on the Moon. Sadly, it did not turn out the way he planned. A few weeks after arriving at NASA in 1966, part of his preparations for assignment to a flight as CMP involved a technical assignment to the Space Environment Simulation Laboratory, or SESL, at MSC, which was essentially a vast chamber capable of simulating the vacuum and extreme heat/cold conditions of space. Teamed with fellow astronaut Joe Kerwin and Air Force Captain Joe Gagliano, the three men 'flew' the simulated six-day mission to the Moon that revealed several design flaws and procedural errors.

This assignment must have helped his career chances, because in late 1966, NASA announced the first three Apollo prime and backup crews. Deke Slayton and Jim McDivitt (appointed commander of Apollo 2) felt it was also necessary to have a support crew, to carry out flight-related duties that might otherwise take crew members from vital mission training. All nine of these support crew members came from the Group 5 astronauts, and Ed Givens was delighted to find himself on the support crew for AS-204, or Apollo 1, along with fellow group members Ron Evans and Jack Swigert. Their task was to assist the prime and backup crews with engineering details, gather essential information and carry out pre-flight preparations. Early in 1967, Givens received further confirmation that he was in line for an upcoming mission when he was listed to begin helicopter training, starting on February 27 along with Fred Haise.

A month before Givens began this training, the Apollo 1 crew died in the launch pad fire at the Cape. When NASA announced in May 1967 that the first Apollo Earth-orbiting flight would be Apollo 7, crewed by Schirra, Eisele and Cunningham, the three-man team of Givens, Evans and Swigert became their support crew members. Things were looking good for Givens to progress to an early backup crew, a step closer to a prime crew. However, a tragic twist of fate meant that he would not live to complete those assignments and realize his dreams.

In the late evening of June 5, 1967, Ed Givens left a meeting of the Quiet Birdmen, a fraternal organization interested in aviation, at the Skylane Motel on Telephone Road in Pearland, Houston, Texas, along with two air force reservists he was taking to their quarters at Ellington AFB. Shortly after midnight, he drove his 1964 Volkswagen Beetle sedan onto the busy road, which was glistening with recent rain. Unfortunately, he took a wrong turn onto Knapp Road, which had a poorly-lit, notoriously bad 90-degree bend further down. Seeing the bend too late, he braked, but the car skidded and plunged into a deep ditch. His passengers were injured in the crash, but Givens was thrown forward, smashing into the steering column. He suffered a crushed sternum and massive internal injuries, and died on the way to hospital. His wife was notified of the tragedy by Dr. Charles Berry, Director of Medical Research and Operations, MSC, Deke Slayton, Director of Flight Crew Operations, MSC, and fellow Group 5 astronaut Stu Roosa. [20]

A memorial service for Givens was held at Seabrook Methodist Church on the morning of June 9, followed by a funeral service in the afternoon at the first Baptist Church, Quanah, Texas. Givens was laid to rest at the old cemetery in his hometown, in Quanah's Memorial Park. The six pallbearers at his funeral were the prime crew (Schirra, Eisele, Cunningham) and backup crew (Stafford, Young and Cernan) for the first manned Apollo flight, with whom Givens had closely worked. The traditional 'Missing Man' formation of aircraft was flown over both services by three of his Group 5 colleagues (who were not identified at the time). [21] He left behind a very young family – a daughter, aged four, a son, almost three, and a second daughter, just ten weeks old. To assist and support the family in making the necessary arrangements, Joe Engle was appointed the summary court officer. [22]

The loss of Givens was especially difficult for his colleagues from the 1966 selection. Apollo 15 astronaut and Group 5 colleague Al Worden has said that Givens receives too little recognition for his brief time as a NASA astronaut: "He is overlooked because he died in a car, not a plane. It would have been interesting to find out what flights Ed might have been assigned to." Ed Givens did make it to the Moon, albeit in a symbolic way, when the crew of Apollo 15 left a printed plaque bearing his name as a Fallen Astronaut on the lunar surface. [23]

Members of the original third Apollo (E-Mission) crew during LM familiarization training. (From left): Borman, Collins and support crewman Carr.

Small steps towards a giant leap

A lot of work remained if America was to reach the Moon by the end of the decade, and a significant amount of hardware and missions required testing to accomplish that feat. Clearly, a plan to identify key steps on the road to the Moon was required. The Chief of MSC Operations Division, Owen Maynard, recognized this shortfall and so devised a sequence of seven steps that could be assigned to a single mission, or to a series of flights, following a systematic progression towards the lunar landing missions. Together with the cancellation of several missions to save time, funds and energy, this new plan proposed testing complete components, rather than one element at a time, and was termed 'all up testing'. The seven-step principle was revealed on September 20, 1967:

- *A Mission:* Including unmanned Saturn V and CSM development missions to an apogee of 10,000 miles (16,093 km) on missions lasting about 8.5 hours.
- *B Mission:* An unmanned LM development flight, using the smaller Saturn 1B to test the propulsion and staging systems in a low elliptical orbit, lasting approximately six hours from launch and without recovering the LM.
- *C Mission:* Saturn 1B manned CSM evaluation in low Earth orbit for between ten and eleven days, more than enough time for a flight to the Moon with a short stay landing.
- *D Mission:* Saturn V (or dual Saturn 1B) manned development flights with the CSM and LM in low Earth orbit for up to eleven days.
- *E Mission:* Combined CSM and LM operations for up to eleven days in high apogee Earth orbit, launched by Saturn V.
- *F Mission:* A further deep space evaluation of the CSM/LM combination, launched by Saturn V, to include lunar orbital operations on an eight- to ten-day mission.
- *G Mission:* The initial lunar landing attempt, to include a single surface EVA of about three hours, the deployment of surface experiments and collection of samples, in a mission lasting about eight days.

Later this sequence would be expanded to include:

- *H Mission:* Ten-day lunar missions, with two surface EVAs on foot, deployment of ALSEP, collection of geological samples and photography of future landing sites from orbit.
- *I Mission:* Lunar orbital survey missions without landing. (This category of mission was not flown; instead, the objectives were incorporated into the three flown 'J' missions.)
- *J Mission:* Extended duration 'super-science' landing mission, to include three periods of EVA on the surface, supplemented by advanced transportation devices, in-depth surface and orbital explorations programs.

If Apollo had continued with the proposed extended series of missions under AAP, they could well have been assigned mission categories such as K, L, or M.

These mission types, through to the J-series, would be adopted for the duration of the Apollo program into 1972 and worked well. The complexity and scope of these missions, with their increasingly advanced hardware, intricate planning and challenging objectives, resulted in ever-increasing activities, not only for the prime crews and their backups, but also the support crews. There were countless technical meetings, briefings and simulations, and numerous memos passed between the crews, members of the Astronaut Office, NASA management and contractors. The members of the Class of '66 fulfilled their roles admirably (as did the members of the 1969 selection later) over the next eight years.

Yet another loss

Just four months after the loss of Ed Givens, yet another tragedy befell the Astronaut Office and the NASA community in Houston. Group 3 pilot C.C. Williams was killed on October 5, 1967, the day after the tenth anniversary of the dawn of the space age. He had ejected too low after the controls on his T-38 jet plane locked and he lost altitude on the way back to Houston from an assignment in Florida. [24] Williams became the eighth astronaut to lose his life while on active duty with NASA, the fifth such loss in 1967. Williams had been assigned as LMP on Pete Conrad's Apollo crew, alongside CMP Dick Gordon, and had also been in training as backup to McDivitt's second Apollo crew. He was in line to fly the sixth manned Apollo mission. The loss of Williams resulted in further reshuffling of Apollo crew members and technical assignments in the Office.

Group 3 astronaut Alan Bean was moved from Chief of AAP to replace Williams on the Conrad crew, and he in turn was replaced by Gordon Cooper, whose position as Chief of the Booster branch was taken by Stu Roosa in November. Other recent moves had already seen CSM specialist Bill Pogue reassigned from AAP to replace Ed Givens on the support crew for Apollo 7. As Buzz Aldrin had been assigned to Armstrong's Apollo crew, he was replaced on the CSM 2TV-1 thermal vacuum test crew by Joe Engle. Bill Pogue's place on AAP was not filled.

More tragedies

Having already seen the loss of the Apollo 1 crew, Ed Givens and C.C. Williams in the space of ten months, and with the cosmonauts having lost Vladimir Komarov, the *Annus Horribilis* (Horrible Year) ended with news that former MOL astronaut, X-15 pilot Mike Adams, had been killed on November 15, in the crash of the X-15 #3 aircraft on the very flight in which he attained his astronaut rating. Then, on December 8, in the eighth loss of a space explorer in this same year, active MOL astronaut Robert Lawrence was killed in the crash of his F-104 at Edwards AFB, California (see page 220).

Apollo gaining pace

The final two months of the year also saw increased activity in the Apollo program. Work was progressing from the recommendations of the AS-204 Review Board and on November 11, the first Saturn V was launched, unmanned, after almost a decade of development. It was a highly successful flight, with the three-stage Saturn sending the unmanned Apollo CSM to an apogee of 11,500 miles (18,507 km) into space, before 'falling' back to Earth to simulate re-entry speeds from the lunar distance.

The following week, on November 20, NASA named the flight crews for the second and third (designated D and E) manned Apollo missions. The second mission would be crewed by CDR James McDivitt, CMP David Scott and LMP Russell Schweickart, backed up by Charles Conrad, Richard Gordon, and Alan Bean. This would be the first flight with both the CSM and LM and would include crew transfer, rendezvous and docking, and EVA. For this final flight of 1968, the Saturn V would be manned for the first time. Given that it was such a complex mission, the support crew were named as Ed Mitchell, Fred Haise (both LM specialists) and Al Worden (CSM specialist).

For the third manned Apollo, CDR Frank Borman, CMP Mike Collins, and LMP Bill Anders would be backed up by Neil Armstrong, Jim Lovell and Buzz Aldrin. Planned as an early 1969 mission in high Earth orbit with a 4,000-mile (6,437 km) apogee, the crew were to simulate lunar landing events and a maximum distance rendezvous with the LM of several hundred miles. For this highly complex mission, the assigned support crew were TK Mattingly (CSM specialist), Jerry Carr and John Bull (both LM specialists). [25]

[Insets] Irwin (in blue) and Bull (in white) conduct suit mobility and reach tests in the new Apollo pressure suits. [Main picture] John Bull models the new A7L pressure suit. (Courtesy Ed Hengeveld)

Suited for space

In September 1967, the first two Apollo pressure suits to incorporate the recommendations of the AS-204 Review Board arrived at MSC. Designated the A-6L, they were assigned to thermal-vacuum and compatibility testing, with delivery of the first production models of the suit, designated A-7L, occurring the following month. Where possible, flammable material had been replaced with non-flammable or low flammability material and the revised suit, with the integrated thermal meteoroid protective clothing, was more comfortable than earlier designs. The A-7L would also eliminate pressure point issues experienced during tests using the original A6-L suit. Following unmanned tests of the A6-L to 150,000 ft. (45,720 m) in the Crew Systems Division's 8 ft. (2.43 m) chamber, Jim Irwin and John Bull began manned tests in mid-December, with Irwin completing a four-hour test on the first day, followed by Bull on a similar run the next day. During the tests, each man performed tasks to anticipate the workload of the upcoming LTA-8 tests. They also recharged the Portable Life Support System (PLSS), though they did not wear these. Instead, they were installed on a stand, and they adjusted controls and settings while wearing their pressure suit. This was useful preparatory work in advance of both men participating in the manned testing of the LTA-8 in Chamber B, Building 32, MSC, early in the new year. [26]

Organization of the Apollo Applications Branch Office

In a memo dated December 8, 1967, yet another new organizational chart for AAP was released. [27] The memo stated that both manpower and other resources that the FCOD could apply to AAP were quite limited, so efforts had to be planned and directed on a priority basis to ensure the FCOD developed the operational capability of the program in line with the development of the missions and launch schedules. As a result, the efforts would be organized on a per-mission basis, with individuals serving as focal points to plan and coordinate the work related to each specific mission. Those from the 1966 selection with specific responsibilities for each flight were listed as PJ Weitz (AAP-1A) and Jack Lousma (AAP 2/3). Scientist astronaut Owen Garriot would handle issues relating to AAP3/4, and all would report to Branch Chief Gordon Cooper, who had taken over from Al Bean after the latter's move to the Conrad Apollo crew.

ON THE EDGE OF THE NEW OCEAN

It had been a tough twelve months. The year 1967 was supposed to have been a celebration of the first decade of space exploration, but culminated in more tragedies than triumphs. The year had been difficult not only for the families of those lost, but also for the remaining members of the Class of '66, for NASA and for the space community in general, including those involved with MOL. Even the Soviets had not escaped setback and loss.

The new year promised much, and needed to deliver on those promises if the Moon was to be reached by the end of the decade. There would still be tough times ahead, but the tenacity within NASA and the belief in its own ability, despite outside distractions and uncertainty, would result in the next few years creating the most iconic period in NASA's history, a period in which members from the fifth astronaut selection would emerge from the shadow of America's space pioneers to stamp their indelible mark in the pages of space history.

References

1. ***Gemini, Steps to the Moon***, David J. Shayler, Springer-Praxis 2001; and ***Praxis Manned Spaceflight Log 1961-2006***, Tim Furniss and David J. Shayler, with Michael D. Shayler, Springer-Praxis, 2007
2. Memo from Alan B. Shepard to all astronauts and directorates, Subject: *Astronaut Technical Assignments*, October 3, 1966, from the Curt Michel Collection, Rice University, copy in the AIS archives
3. ***Moonwalker***, Charlie & Dottie Duke, Oliver Nelson Publishers, 1990, pp. 94-95
4. *Apollo Ends Six-Day Chamber Test*, MSC Space News Roundup, November 11, 1966, p. 8
5. ***NASA's Scientist-Astronauts***, David J. Shayler and Colin Burgess, Springer-Praxis, 2006
6. ***Apollo: The Lost and Forgotten Missions***, David J. Shayler, Springer-Praxis, 2002, pp. 111-128
7. Memo from Deke Slayton to all astronauts and other directorates, Subject: *Block II Apollo flight crew designations*, November 29, 1966, from the Curt Michel Collection, Rice University, copy in the AIS archives
8. December 5, 1966, Pilots' Briefing, CB, MSC, from the Curt Michel Collection, Rice University, copy in the AIS archives
9. Jan Evans: interview by Jennifer Ross-Nazzal for *Air & Space* magazine article, *The Astronaut's Wife*, issue June 2013, pp. 66-69
10. ***Around the World in 84 Days***, David J. Shayler, Apogee Books, 2008, p. 72
11. ***Falling to Earth***, Al Worden with Francis French, Smithsonian Books, 2011, p. 85
12. ***Flying Higher and Faster***, Vance Brand, Mira Digital Publishing, 2015, p. 73
13. ***Moonwalker***, Charlie & Dottie Duke, Oliver Nelson Publishers, 1990, pp. 96-97
14. Email to David J. Shayler from Robert Crippen, 24 January 2017
15. Memo from Al Shepard to Al Bean, April 4, 1967, from the Curt Michel Collection, Rice University, copy in the AIS archives
16. ***Apollo: The Lost and Forgotten Missions***, David J. Shayler, Springer-Praxis, 2002
17. MSC News Release, MSC-67-22, May 9, 1967
18. Memo from Al Shepard's to all astronauts and other directorates, Subject: *Astronaut Technical Assignments*, May 18, 1967, copy in the AIS archives
19. *Crane Hits Power line, One Killed, Two Injured*, MSC Space News Roundup, Vol. 6 #17, June 9, 1967, p. 8
20. MSC News Release, MSC 67-30, June 6, 1967
21. MSC News Release, MSC 67-31, June 7, 1967
22. *Auto Accident Kills MSC Pilot Givens*, MSC Roundup, Vol. 6 #17, June 9, 1967
23. ***Fallen Astronauts***, Colin Burgess and Kate Doolan, University of Nebraska Press, Lincoln, NE, 2003

24. ***Disasters and Accidents in Manned Spaceflight***, David J. Shayler, Springer-Praxis, 2000, pp. 83-84
25. MSC News Release, MSC 67-67, November 20, 1967
26. *Newest Apollo Suit Man-Rated*, MSC Roundup, Vol. 7 #4, December 8, 1967
27. Memo from Director of Flight Crew Operations [namely Deke Slayton, but the original memo was signed by D. Gregory], Subject: *Organization of FCOD Apollo Applications Effort*, December 8, 1967, copy in the AIS archives

6

Before this decade is out

"Roger, … Tranquility, we copy you on the ground.
You got a bunch of guys about to turn blue.
We're breathing again. Thanks a lot!"
Charlie Duke, Apollo 11 Capcom, White Shift,
Mission Control, Houston, July 20, 1969

By the start of 1968, the eighteen remaining members of the Class of '66 had all but completed their basic and survival training programs and had progressed to a variety of support roles in the Astronaut Office. The previous two years had been a time of tremendous changes and challenges for each of them, while the next two years promised so much more, including being at the forefront of one of the greatest adventures in human history. They were to become personally involved in events that defined the decade and were now at the threshold of making their own contribution to that adventure. But with only twenty-four months of hard work and dedication left to fulfill President Kennedy's challenge, the pressure was on Apollo to achieve its long-standing goal.

SMALL PIECES IN A LARGE JIGSAW

One of the more thrilling aspects of hands-on research into archived files – something that on-line research simply does not give you – is the discovery of an original document, scrap of paper or memo which details events and decisions that affect, or contribute to, key moments in history; holding it in your hands as you read its content. Then, there are the areas of research which remain restricted, hiding potential insights into decisions or events that might provide a new perspective from the point of view of 'inside information.' In space exploration, there remain many such areas of restricted information which could, if made accessible, open up a whole new avenue of research, or provide additional detail

D.J. Shayler, C. Burgess, *The Last of NASA's Original Pilot Astronauts*,
Springer Praxis Books, DOI 10.1007/978-3-319-51014-9_6

to a story or topic. Greater understanding of the inner workings of the NASA Astronaut Office at MSC/JSC in Houston is one such restricted topic. Over the years, numerous articles, memoirs and other books have touched on the mystery of the Astronaut Office, and occasionally a memo or two becomes available to researchers which helps fill in some of the gaps. Once in a while, personal document collections are archived in the history offices of NASA, or donated to the archives of academic institutions, and from these, a wealth of information and understanding can be gleaned that is of value to the researcher. But it is rare to come across a significant collection of documents which include an insight into the workings of the Astronaut Office.

Thankfully, one such resource that can be researched, among the extensive collection of documents at Rice University, Houston, was donated by the former scientist astronaut, Curt Michel. While Michel never flew in space, contained within this collection are a wealth of memos, documents and notes which he collected during his four years at NASA between 1965 and 1969. Included is a series of Astronaut Office memos, some marked 'For Internal Use Only' and which, together with Michel's hand-written notes, highlight some of the crewing and assignments during that period.

Some of these undated notes certainly originate from either late 1967 or early 1968, and the challenge for the researcher lies in piecing together the story in between these and other documents. Linked to one hand-written note is a subsequent memo from Chief Astronaut Alan Shepard, dated May 1968. In it, Shepard refers to a crewing update issued on January 17, 1968. Therefore, Michel's undated note probably originates from one of the weekly Monday morning pilot meetings prior to that January 17 memo. Unfortunately, there is not a complete collection of Office memos from that period in Michel's collection, but those which are present give a valuable insight into the workings of the office during the critical years of the Apollo program.

Within these documents are details of the crewing for the first three Apollo crews, commanded by Schirra, McDivitt and Borman, as well as their backups and the support crews. Several versions of these notes are included in the collection, indicating the evolving process at the time, such as whether to have a three-person support crew for the CSM-only Apollo 7 (Schirra), and perhaps a four-person support crew for the more technically challenging Apollo 8 (McDivitt) and Apollo 9 (Borman) that included the first CSM and LM combinations. In one of these notes, Jerry Carr is listed in the support crew for either the second or third manned Apollo, while Jack Swigert was added to the third manned Apollo, presumably drawing upon his experience supporting the first one. Clearly, the plans being discussed in these meetings were very fluid, with Michel's own notes recording possible crewing outcomes from those discussions.

It can also become a challenge for a researcher to detail the assignments of an astronaut *in between their spaceflights*, which is where most of their work is accomplished but which is seldom reported. From memos such as these, a researcher can gain an insight into the day-to-day activities of an astronaut when they are *not* in space. From the Michel notes and memos of late 1967 or early 1968, changes were also recorded for some of the Group 4 (scientist) and Group 5 (pilot) technical assignments. For example, Joe Kerwin was assigned to pressure suits and TK Mattingly held responsibility for the Portable Life Support System (PLSS). Other technical assignments listed in the memo included: KSC

Altitude Chamber Review Board (Irwin with Cernan); 20 ft. (6.09 m) Altitude Chamber Review Board (Mattingly); Lunar Receiving Laboratory (Kerwin); Fire Review Board for the CM (Brand), Fire Review Board for the LM (Irwin); Simulator Configuration Change Panel (Swigert); and the Apollo Telescope Mount Confirmation Committee at MSFC (Ed Gibson).

From these small snippets of information one can put together a story revealing the larger picture, adding individual pieces to the jigsaw; in this particular case, how the Astronaut Office was organized in the later years of the 1960s.

"THE TIMES THEY ARE A-CHANGING"

At the start of 1968, it had been twelve months since the horrendous pad fire that had claimed the lives of the Apollo 1 crew. There were also less than two years left to the deadline set by President Kennedy of landing Apollo astronauts on the Moon, "before this decade is out." The new year would be another twelve months of evaluating hardware, systems and procedures, but would also push the boundaries of Apollo far from Earth. It was also a year when members of the fifth astronaut group began to occupy key positions of support in that final push to the Moon. That work started right after the Christmas holidays.

Tests, simulations & mock ups

In January 1968, Stu Roosa was in Florida, participating in the first manned test run of a slide wire crew escape system at Launch Complex (LC) 39 at the Kennedy Space Center (KSC). These simulations were typical of the type of support work that an astronaut might be called upon to perform outside of assignment to a specific flight or crew. This type of assignment might last from a few hours to a couple of days, while others might continue for weeks, for months, sometimes even years, as the hardware or processes were developed, rejected or adapted. Sometimes things worked well, other times they did not, as problems with the new systems or procedures were ironed out.

During the preparations for Apollo 7 in 1968, Bill Pogue, a member of the mission support crew, was down at the Cape supporting the many procedures that must be followed prior to a launch. One day, Roosa asked Pogue to stand in for him in a planned manned test run the next day, as he had to return to the Manned Spacecraft Center (MSC) in Houston for an important meeting. As the complete quarter-mile (402 m) slide wire was considered too risky to use for this routine test, Pogue, along with his astronaut colleague Ron Evans and eight volunteers from KSC, were to exit the basket platform attached to the slide once it was near to its end of its run, some 35 ft. (10.66 m) above the ground. Each man would use a rescue sling attached to a pulley, which incorporated a safety device to prevent sliding backwards. They would then slide individually down the rest of the wire in staggered, five-second departures. As they approached the end of the wire it would naturally sag, allowing each test subject to detach from the collar quickly and drop onto a trampoline designed to absorb their descent and forward motion.

The first human test-run of the Slide Wire Escape System, Pad 39. (L to R): Safety Rep. Chuck Billings, Stu Roosa and Design Engineering Rep. Art Porcher. [Inset] Pogue and Evans participate in a slide wire test at Pad 34. (Courtesy Ed Hengeveld)

The next morning, Pogue did not receive the call to attend the test, so he drove out to the test area, noting that pieces of wood and lead were strewn all over the ground near the approach path to the trampoline. He was told that during the required safety run prior to the manned test, the wood and lead anthropometric dummies, simulating the size of an average man, had revealed a serious problem with the system. Each of the ten dummies was released at the planned five-second interval and by the time the first approached the end of the wire, it was traveling considerably faster than planned due to the combined weight of the other nine. This negated the intended sag in the wire. When the first dummy hit the trampoline the dolly system locked, thus preventing backward motion, but the dummy twice bounced back onto the trampoline. Then the second dummy, arriving five seconds later, hit the first and shattered both. Five seconds later, the third dummy struck the debris and showered splinters of wood and lead all over the area. The other dummies added to the affray, forcing the manned test to be cancelled until adjustments had been made. Still, the event gave the eyewitness reporters a demonstration of the safety procedures for Apollo astronauts, and great copy and pictures for the following day's local papers. **[1]**

All suited up

In other tests during January 1968, Jim Irwin and John Bull continued to evaluate the newly-configured pressure suit in a series of four-hour verification test runs, inside NASA's eight-foot altitude chamber located in MSC's Crew Systems Division. The redesigned suits, in addition to being covered with non-flammable Beta Fabric fiberglass cloth, were far more comfortable and mobile than the original suits [2]

During the chamber tests, in which the chamber used ambient air, the two men's pressure suits utilized a 100 percent oxygen system at 3.7 pounds per square inch. (0.255 bar) [3] Conducted at simulated altitudes of up to 240,000 feet (73,152m), these tests were preparatory to trials of Grumman's Lunar Module Test Article-8 (LTA-8) in Chamber B within the Space Environment and Simulation Laboratories (SESL). On January 13, Irwin completed a three-hour suited verification simulation of a crewmember transfer from CM to LM and back again through the internal tunnel. [4] In these new tests, NASA simulated as close to the space environment as possible, for both the Command and Service Module (CSM) and the Lunar Module (LM). [5]

As before, Irwin and Bull teamed up for the LTA-8 thermal vacuum tests. This was a crucial checkout of the Lunar Module Test Article, scheduled for completion in June. Space historian Ed Hengeveld wrote about these tests in an article for *Spaceflight* magazine in April 2000: "The two LTA-8 crewmen would perform the full range of activities that would be necessary during an LM's flight to and landing on the Moon. They would simulate firing the descent and ascent stage engines. In addition, they would practice unhooking their spacesuit umbilicals from the LM's Environmental Control Subsystem and switching to the Portable Life Support System, the backpacks that contained the air supply and cooling to keep the astronauts comfortable while working on the lunar surface. Then they would depressurize the LM cabin, open the hatch, crawl out onto the porch and descend the ladder to simulate activities on the lunar surface." [6]

Elsewhere, on January 18, Al Worden was working as a support crewmember for the second manned Apollo (McDivitt's flight), representing the flight crew. He was a member of a special task team reviewing contamination control issues on CSM-103, the spacecraft intended for use by the McDivitt crew. As preparations for the mainline Apollo program continued, so did those geared towards the Apollo Applications Program (AAP), keeping all members of the CB occupied. In mid-February, a five-day Orbital Workshop (OWS) crew station review for AAP was completed at the Marshall Space Flight Center (MSFC) in Huntsville, Alabama. Participating in this review were Gordon Cooper, Bruce McCandless, Stuart Roosa, Jack Lousma and Ed Gibson. The astronauts walked through the updated engineering mock-up of the OWS and completed simulations of the tasks that would be required for AAP crews to activate it on orbit. [7]

During the same month, the NASA Apollo Site Selection Board chose five primary landing sites for the first Apollo lunar landings. The list had narrowed from the 30 sites originally proposed to just eight, under a detailed study that focused efforts towards deciding which of these areas would be the best for the first landing. The data came from surface photos taken by the Surveyor soft landers, as well as imagery from the Lunar Orbiter probes. Using these pictures, a detailed search for suitable landing sites for Apollo could begin, not only for the first landing, but for targeting later ones to more challenging sites. With these landing sites chosen, the Moon seemed to be one step closer, especially to those who were preparing to go there in person.

Roosa, with Duke behind him, during the CM-007A sea trials. [Inset from left] Duke, Jim Lovell and Roosa. (Courtesy Ed Hengeveld)

On March 1, the Apollo 007A water egress crew, comprising Commander (CDR) Jim Lovell, Command Module Pilot (CMP) Stu Roosa and Lunar Module Pilot (LMP) Charles Duke, completed a Command Module (CM) egress training session. In this final preparation for the actual test, which occurred between April 5 and 7 in the Gulf of Mexico, the crew used the same spacecraft they would occupy the following month. [8] For two days, the three astronauts 'lived' in Spacecraft 007A, a production CM configured for post-landing with a representative heat shield. Onboard systems were identical, or similar, to those set up for Spacecraft 101, which was scheduled to be the first manned Command and Service Module (CSM) mission, Apollo 7, that October. The weight, center of gravity and moments of inertia were calibrated to be the same for both craft. The self-righting system was used to orientate the CM from Stable II (Apex down) to Stable 1 (Apex up), and the spacecraft also featured VHF and UHF antennae, search beacons and communication equipment, sea dye markers, swimmer interphones (for the crew to talk with para-rescue divers outside without opening the spacecraft hatch) and the post-landing ventilation system. Inside, the couches, paneling, switches and internal arrangement duplicated the flight equipment as far as possible, as did the crew suits and umbilical connectors, in order to make the exercise a realistic representation. [9]

Charlie Duke could never understand why they volunteered for the test, joking that he believed Jim Lovell had talked them into participating. As new astronauts, they thought it would be useful experience in preparing for their own flights in Apollo, but once they were sealed inside the CM on the water and the humidity levels began to rise, they realized it might not have been such a good idea after all and was extremely boring. Despite being configured to look like a real spacecraft, the panels and systems were just mockups, which meant the astronauts could only talk to each other, sleep and take Marezine medication for their motion sickness. Four decades after completing the exercise, Duke still felt it was the worst thing he did during his time as an astronaut.

Office technical assignment updates

On May 8, Alan Shepard issued a new memo listing technical assignments for the group, updating his earlier memo of January 17. These changes were necessary, Shepard stated, because of the imminent start of operational checkout procedures for Spacecraft 103 (McDivitt crew). **[10]** In this memo, the single points of contact were now listed as:

- Apollo Mission Operations & Software (Armstrong)
- Command Module Hardware (Lovell)
- Lunar Module Hardware (Aldrin)
- Apollo Applications Program (Garriott)
- LTA-8 Tests (Irwin)
- 2TV-1 Tests (Kerwin)
- Boosters/Flight Safety (Roosa)
- Suits/PLSS (Mattingly)
- Command Module Fire Board (Brand)
- Lunar Module Fire Board (Irwin)
- Simulator Configuration Change Panel (Worden)
- Apollo EVA Task Force (Scott)
- Lunar Receiving Laboratory (Kerwin)
- 20 ft. Chamber Review Board (Mattingly)
- KSC Altitude Chamber Board (Haise)
- MSFC ATM Committee (Gibson)
- Headquarters Astronomy Mission Board (Garriott)

1968, a worrying year

The year of 1968 proved to be a pivotal one, not only for Apollo and NASA, but for the United States as a whole. The conflict in South East Asia was escalating and reports on TV bulletins brought the realities of war into the homes of Americans almost every night, though no mention was made of the fact it was a war that America was not winning. In these troubled times, civil rights marches continued to receive banner headlines in the press, with race riots first erupting in 1967. Then, the April 4 assassination of Martin Luther King Jr., by James Earl Ray in Memphis, Tennessee, was followed just eight weeks later, on June 6, by the death of Senator Robert F. Kennedy, who had been shot and fatally wounded the day before by Sirhan Sirhan while out campaigning for the Democratic nomination for president. This situation was stressful for everyone, even those deep into the effort to reach the Moon, as Gene Kranz recalled in 2000. "[By the late 1960s] the space program was picketed and bomb threats were reported. Everything we carried into the Mission Control Center was inspected. Security guards roamed our parking lots during missions. We practiced bomb threat evacuation from Mission Control, always leaving a small team to hold the fort if we had a crew aloft." **[11]** Apollo became a beacon of hope for many during those dark days. Occurring at the same time as all these events, but lower down the headlines, was the arrival of the new group of eleven scientist astronauts in September 1967. After completing six months of academic training, they would all go off to flight school for a year. **[12]**

In addition, 1968 was also a presidential election year, in which budget cuts were expected for NASA that would seriously affect long term planning for both Apollo and AAP. Despite CIA information that the Soviets were threatening to win the perceived competition to get to the Moon, there remained a lack of evidence, or missions, to support these suggestions. Throughout all this turmoil, the astronaut Class of '66 remained hopeful that their work in supporting the first Apollo missions would pay off with at least one flight into space, if everything went to plan.

Problems with Apollo

Over the previous year, the Lunar Module (LM) had encountered problems, including increased weight, wiring issues and corrosion, which had seriously delayed its first manned flight and made the series of ground tests manned by Irwin and Bull using LTA-8 even more important.

On April 4, 1968, the second unmanned Saturn V was launched as Apollo 6. It was essentially a re-run of the Apollo 4 mission of the previous November (Apollo 5 in January had tested an unmanned LM in earth orbit). This time, however, thrust variations on the first stage induced forward and backward oscillations in the vehicle, akin to a pogo stick, for approximately 30 seconds. This movement, known as the 'pogo effect,' exceeded modulation limits, while associated buffering also caused a panel in the adapter section to fail. Two of the J-2 engines then failed on the second stage, causing the other three engines to burn longer than planned and depleting the fuel intended to place the vehicle in its planned orbit. Problems also occurred with the single J-2 engine on the third stage.

Though the CSM performed nominally and was recovered after a 10-hour flight out to 13,800 miles (22,209 km) apogee, things did not look good for sending a crew aloft on the third mission. For a while, it seemed the next flight might have to be a third, costly, unmanned test mission. With this in mind, and because of the urgency to resolve the problem, Charlie Duke – who was still assigned to the Booster Branch Office – traveled to the MSFC on May 25 so that he could be involved in resolving the issues and coordinate the information back to the CB. Within weeks, the issues had been settled, by making small tweaks to the design and performance of the engines and stages, which meant that NASA could progress to a manned flight on the third Saturn V launch. It was one of many routine assignments for the astronaut, the kind mostly overlooked by the media, but one which was vitally important to complete if the flights were to move forward without serious delays or extra costs. **[13]**

Will there or won't there? That is the question

Throughout these ongoing developments, the geology training continued in support of the Apollo lunar effort. But with an escalating bill from the nation's unpopular involvement in South East Asia, some hard-hitting headlines at home, and the prospect of budget cuts by a new president, there were serious doubts about the future of the space program. Connected to these uncertainties, the authors discovered an interesting memo from Jack Schmitt within the Michel collection. Dated May 14, 1968, with the first lunar landing on the horizon, Schmitt reminded the members of the "Incredible 5" (Group 4) and the "Original 19" (Group 5) of the opportunities for proficiency training in geology. He sent a schedule of field work, field trips and seminars which were being planned as part of the geologists' own research program, but as Schmitt said, "All have agreed that if any of us care to join them, they will be more than happy to be instructors and informal tutors for those interested in brushing up and polishing their backgrounds in academic areas and field training." The most revealing comment, however, was a reference to the uncertainty over whether all this geology work would be put into operation in space: "As you know, we are faced with two possibilities: either there *will* be a space program or there will *not* be a space program. If there is, geology will be a valuable skill in either the lunar or the Earth resources program. If there is not, geology offers an enjoyable career even for ex-fighter pilots and physicists." **[14]** Even the Astronaut Office, it seemed, was having doubts about the long-term future.

Apollo CM 2TV-1 prime crew. (L to R): Brand, Engle and Joe Kerwin in a less formal crew photo. [Inset left] Engle and Kerwin (on couch), [right] Brand. (Courtesy Ed Hengeveld)

"A SIGNIFICANT MILESTONE IN THE APOLLO PROGRAM"

These words were spoken on the morning of June 24 by Structures and Mechanics Division Chief Joseph N. Kotanchik, at the conclusion of the Apollo CSM manned thermal vacuum test designated 2TV-1. This eight-day test of the CSM in thermal vacuum conditions had begun on the morning of June 16, when astronauts Joe Kerwin (acting as spacecraft CDR), Vance Brand (assuming the role of the CMP), and Joe Engle (as LMP) entered spacecraft 2TV-1, located in space simulator Chamber A. That afternoon, the crew doffed their pressure suits and donned the constant wear garments and inflight coveralls that a real Apollo crew would wear to make them more comfortable during their time in the CM.

Designed solely as a test and evaluation vehicle, the 2TV-1 had nevertheless been manufactured to the same specifications as the flight vehicles, with most of the materials and almost all of the flight-qualified instrumentation and equipment installed as they would be for actual missions, incorporating many of the recommendations and changes instigated by the Apollo AS-204 Review Board. The CM, in particular, was configured as close to the actual flight-ready Spacecraft 101 (Apollo 7) as possible. The primary objective of the test was to qualify the structure of the spacecraft, the pressure vessel and the environmental control subsystem, in similar temperatures and vacuum extremes to those likely to be experienced in space on actual missions. The test was programmed to subject the CSM to temperatures ranging from -150 deg. F (-101.11 deg. C or 172K) to +150 deg. F (65.5 deg. C or 338.7K) in a vacuum equivalent to an orbital altitude of 130 miles (209.2 km).

Throughout the week, the three astronauts followed a similar flight plan to that of a crew in space and apart from the weightlessness, their 'flight' was very much like a real mission; eating from the menu of Apollo food, sleeping, operating guidance and navigation equipment, simulated engine firings, and activating and checking spacecraft systems. The 'mission' was divided into six main phases: Crew ingress and a 19-hour chamber pump down phase; a 15-hour 'hot soak' with the CM orientated towards the top solar simulators; a 15-hour 'cold soak' during which the solar simulators were turned off; 45 hours with the chamber-side solar simulators providing maximum heating to the SM; and 72 hours of alternate and contingency operations. The test then concluded with a 12-hour entry phase.

Medical reports indicated that all three men had performed well, eating and sleeping normally. The spacecraft cabin had been pressurized with a mixture of 60 percent oxygen and 40 percent nitrogen at the start of the test, with pure oxygen slowly replacing the 60/40 mix following the pump down of the chamber. This replicated actual missions, where a 60/40 ratio at 160 psi (11.031 bar) was planned for launch pad operations, and pure oxygen at 5 psi (0.345 bar) for space operations. At the completion of the test, the chamber was brought back to normal levels, allowing the crew to exit though the man-lock. A team of over 600 worked at the SESL during the test, with a further 200 employees and contractors working across various locations at the MSC site. Once outside, the simulation crew looked forward to some real food, a shower, and a spell in a real bed. **[15]**

LTA-8 an Unqualified Success

On May 15, Jim Irwin and John Bull had been assigned to the LTA-8 thermal testing planned for between May 27 and June 1. However, days before the tests were to begin, Bull had been forced to withdraw from the tests due to an underlying medical condition and had to be replaced. There were no astronauts available to take his place at the time, so a Grumman pilot, Gerald Gibbons, stepped in while the issue with Bull was investigated further.

The vacuum tests were still completed on time and were deemed highly successful. The backup crew to Irwin and Gibbons consisted of Glennon Kingsley, a Grumman consulting pilot, and Joseph Gagliano of MSC Crew Systems Division. According to SESL Manager James McLane, summarizing the tests, the preliminary data indicated all the testing requirements had been met to certify the LM for manned spaceflight. Originally planned for two weeks, the tests were completed in a single week because of the excellent performance of the vehicle and the Chamber being used, allowing two phases to be run back-to-back. There appeared to be no obstacles to allowing LM-3 to fly as planned with a crew. Twelve-hour tests were completed by CDR Irwin and LMP Gibbons on May 27, May 29 and June 1, while backup CDR Kingsley and LMP Gagliano completed a ten-hour test on May 31.

During the tests, the crews performed tasks simulating those which would be conducted in Earth orbit and on lunar missions with the LM. Systems were activated and checked out, the onboard computers were used, and they performed realistic simulations of maneuvers and engine firings. The tests were designed to ensure the vehicle would perform in the correct environmental conditions and were divided into two phases; the first simulating Earth-orbital flight and the second at maximum solar heating. However, due to poor communications and data flow, Irwin's operation of the PLSS – transferring from the spacecraft life support to the backpack – could not be performed. The tests included some milestones, in that it was the first time a crew had entered and exited a spacecraft in hard vacuum, and involved the first unscheduled repair under vacuum conditions by a crewmember (Gibbons) on the hinge pins of the hatch. These pins were installed with a minimal break force to allow an emergency exit or entry, but for the tests to continue they had to be repaired – under vacuum conditions in pressure suits as the final day required a pressurized LM cabin – or the whole test day would have been lost. Irwin commented on the physiological effects of entering the chamber for the first time in a vacuum, noting that this probably played a part in his raised pulse rate. **[16]**

Putting the backpack through its paces

During June 1968, a series of five tests, totaling 8 hours, were completed in Chamber B of the SEC to evaluate the PLSS backpack intended for use in conjunction with the pressure garment on the surface of the Moon. Leading this effort was TK Mattingly who, in addition to becoming a specialist on CSM systems and procedures, had also spent hours working in support of the development of the Apollo pressure suit and life support backpack. On June 21, Mattingly completed a 4-hour test run in Crew Systems Division's 8 ft. (2.43 m) vacuum chamber at MSC, evaluating the PLSS to be worn by Rusty Schweickart on the EVA that was scheduled for the second manned Apollo mission at that time. This followed two unmanned tests of the PLSS in the same chamber on June 14 and 15. **[17]** There was also a 3-hour test by Apollo 8 LMP Rusty Schweickart on June 29, and a 4-hour test by his backup, Al Bean, later that same day. **[18]**

[Inset top] Irwin leads Bull during the fully-suited LTA-8 & PLSS test program. [Inset bottom] John Bull, who was forced to withdraw from the astronaut program. [Main picture] The tight confines inside the LTA-8 are very evident in this image. (Courtesy Ed Hengeveld)

BULL'S MYSTERY ILLNESS

Prior to the LTA-8 vacuum tests, Irwin and Bull had carried out several emergency egress exercises to test evacuation procedures from the chamber. This required both men to don oxygen masks before exiting the LTA through the hatch and making their way onto the porch and down the ladder to leave the chamber.

The first inkling of a medical problem for Bull had occurred earlier, in August 1967, when he was treated for sinusitis. By November, he had developed another slight cough and in January 1968, he experienced his first severe asthma-like attack. While conducting these evacuation exercises, Bull's sinus condition seemed to be aggravated by the constant pressure changes. Initially, the mystery illness puzzled the NASA doctors but when it persisted, their concerns grew. Taking aspirin only seemed to make the condition worse. Treatment for the unknown pulmonary condition continued, but by mid-May, Bull's condition had not eased and the space agency had no option but to stand him down from the LTA-8 tests. He was replaced by Grumman pilot Gibbons. [5]

In July, an understandably anxious Bull reported to the National Naval Medical Center in Bethesda, Maryland, for an examination to determine whether he was medically fit to remain on active duty in the Navy. NASA also announced that the condition could possibly lead them to ground the well-liked astronaut, "perhaps permanently." To his acute disappointment, the Navy doctors decided that he should be placed on non-flying duties. [19]

At the time of his illness, Bull's disease had no medical name, and no known cure or effective treatment. In fact, it has only been identified in the past few years, as Alpha-1 antitrypsin deficiency. Until then, it was mostly referred to as 'aspirin asthma.' The disease is characterized by three factors: (1) chronic sinusitis, (2) chronic obstructive pulmonary disease, and (3) marked sensitivity and intolerance to aspirin. The progressive disease is not a true allergy, but is much more serious than asthma, most frequently striking young men in their late 20s and early 30s. The lack of knowledge of the disease back in the 1960s had restricted treatment to just alleviation of the symptoms. [19]

On 16 July 1968, NASA announced with reluctance that Lt. Cmdr. Bull would be withdrawing from the astronaut program. In qualifying the announcement, Dr. Charles Berry, NASA's Director of Medical Research and Operations, stated that Bull's condition "has not responded to treatment," adding, "he is a rather ill young man." [20] Bull's departure would leave 53 astronauts active in the NASA program. [21]

During the same month, Charlie Duke continued the work begun by Stu Roosa earlier in the year on evaluating emergency escape systems at the Cape. Duke served as a test subject to demonstrate the Apollo emergency egress slide tube at LC 39. Intended as an alternative escape system to the slide wire and basket system, the slide tube installed at each pad was a 200 ft. (61 m) evacuation tube which ran from the Mobile Launcher Platform (MLP) to the 'rubber room,' a blast-resistant bunker located 39 ft. (12 m) underground, which was stocked with supplies for 20 persons for up to 24 hours. In the event of a pending pad explosion, the pad staff and flight crew could, in theory, slide down the tube and into the room to escape the resulting inferno above. Fortunately, neither this nor the slide wire and basket system were ever called upon in a real emergency.

SWAPPING SEATS ON APOLLO

On July 23, Mike Collins, the CMP on Borman's Apollo crew, had successfully undergone surgery to remove a bone spur from his spine at the USAF Wilford Hall Hospital in San Antonio, Texas. After the operation, Collins was expected to spend the next three to six months recovering from the surgery, which naturally precluded his participation in Borman's Apollo crew. [22] This procedure, along with other unrelated events, signaled a series of seat and mission swaps and led to the first member of the 1966 group being named to a potential flight crew.

Ken Mattingly on Capcom duty during Apollo 8, with Collins, Armstrong and Aldrin looking on. [Inset] Haise (lower right) was backup LMP for Apollo 8.

On August 8, NASA announced the changes to flight crewing as a result of Collins being grounded. It was decided that backup CMP Jim Lovell would replace Collins, while Buzz Aldrin, the original Mission E backup LMP, would temporarily move to backup CMP. Finally, Fred Haise was promoted from the support crew to the backup LMP position. Thus, Haise became that first member of the 1966 selection to be named to a flight crew, as in theory he could then have been reassigned to a prime crew three missions later, though it did not work out quite that way. Jack Lousma took the place of Haise on McDivitt's support crew and Vance Brand filled another slot on the Borman support crew, having earlier replaced Bull after he was forced to withdraw from the astronaut program. **[23]**

Exchange of crews and missions

At the time of the crew amendments to the second and third missions, nothing was said of the discussions and evaluations being carried out behind the scenes. There were two CSMs ready to fly, but the LM would not be available until the following year, so the new plan was to delay the first manned test to early 1969 and move the McDivitt crew with it. His crew did not want to lose the D-mission which they had spent close to three years training for, but this had implications for the Borman crew, who had also trained to fly a LM that would now not be ready until the spring of 1969. To capitalize on their training and make use of the launch slot, Borman's now CSM-only mission was pulled forward and renamed the C-Prime mission. But the most significant change to the second manned flight (now identified as Apollo 8) was that it would no longer just fly out to a 4,000-mile (6,437.3 km) apogee, as had originally been planned for the abandoned E mission. They would instead go all the way to the Moon, circling it ten times over the Christmas holidays. It would also be the first manned mission to use the Saturn V. These changes were announced on August 19. If they pulled it off, it would be an historic mission and a shot in the arm for Apollo; if they didn't and the crew was lost, it could be the death blow to the Moon landing plan. This plan, coupled with the perceived threat of a mission by the Soviets to loop around the Moon before Apollo, meant that 'Moon-race fever' was at an all-time high. We know now that this Soviet mission was indeed planned, with crews in training, but that ongoing problems with Soviet hardware prevented the attempt from taking place.

As the prime and backup crews for the missions of Apollo 8 and 9 were exchanged, so too were the support crews. The Apollo 8 support crew would now be Brand, Carr and Mattingly, with Roosa (replacing Ed Mitchell who was in line to be named as backup LMP Apollo 10), Worden and Lousma supporting Apollo 9.

Roosa had been invited into the support crew role by none other than Alan Shepard who, like Deke Slayton, had been impressed by his work discipline. "Just be patient," Shepard had told Roosa in offering the Apollo 9 support role. "I've got something in the works." **[24]** That 'something' would become clearer a year later.

With the crews for the three missions finalized and in training, work continued behind the scenes to define surface activities for the first and subsequent lunar landings. For a while, Don Lind's technical assignments focused on supporting these developments on the early landings. He followed the development of the equipment and established the procedures required for the two astronauts while they were out on the lunar surface. One of these assignments involved monitoring developments of the Apollo Lunar Surface Experiment Package (ALSEP), fabricated by the Bendix Corporation. According to Lind, this required "a seemingly endless series of design reviews and planning conference meetings across the country." **[25]** It also meant practicing and demonstrating the procedures while wearing a full Apollo pressure suit in one-g conditions, with or without a harness to simulate his reduced mass in lunar gravity. This was carried out aboard a KC-135 aircraft flying parabolic curves, replicating both zero-g and the one-sixth gravity conditions on the Moon, or on longer simulations in a water tank using weights to reproduce the weak gravitational forces that would be encountered on the lunar surface, while battling against the viscosity of the surrounding water. During August 26 and 27, Lind and scientist astronaut geologist Harrison (Jack) Schmitt conducted a full deployment exercise under 1-g conditions with the complete ALSEP. At the time these tests were being carried out, the opinion of NASA's senior management was that any science on the Moon should be secondary to crew safety, at least for the first landing. As ALSEP would take some time to deploy, it was decided to strip back the science experiments for the first mission and trim the two planned EVAs to just one: "The idea was just to get there, grab some Moon rocks, and get back alive," wrote lunar and planetary geologist Don E. Wilhelms in 1993. **[26]** The full ALSEP was deferred to the second landing, with the smaller, less complex Early Apollo Surface Experiment Package (EASEP) assigned in its place for Apollo 11.

The writing on the wall

On September 13, 1968, a month before the first manned Apollo flew, MSC *Roundup* reported that NASA had terminated production of the H-1 engines, used on the Saturn 1B first stage and built by the Rocketdyne Division of North American Rockwell Corporation based in Canoga Park, California. That contract was for a total of 60 engines, and the company had delivered 32 of them to NASA's MSFC up to that point. Of the remaining 28 engines under contract, one had been built and test fired and a second was nearing completion. Another six would be assembled but not test fired, while the remaining 20 were to be delivered "in their present production state." As the *Roundup* article noted: "The purchase of the H1 engines was originally intended for use in missions following the [initial] Apollo manned lunar landing." **[27]** In other words, these engines had been intended for the Apollo Applications missions in Earth orbit to the OWS. Now, with a limited number of completed engines available, future AAP missions, which would have used eight of these engines per Saturn 1B launch, would be restricted. For mainline Apollo, only the first manned flight (Apollo 7) was intended for a Saturn 1B, with all the remaining flights planned for the Saturn V which did not use the H-1. But the limitation in engine numbers would not only restrict the number Earth-orbital flights in support of AAP, it would also reduce the number of flight seats available on Apollo missions launched by Saturn 1B. Even before the first manned Apollo flew, the chances for the Group 5 astronauts of flying into space on these missions had now been significantly reduced.

Apollo 7

Shortly after taking a support role on Apollo 9, Stu Roosa once again found himself in the blockhouse at the Cape, serving as 'Stony' for the launch of the Apollo 7 mission on October 11, 1968. Over eleven days, the three men completed evaluations of the Block II CSM and its systems. This included eight firings of the large maneuvering engine on the Service Module (SM), and a rendezvous with the spent S-IVB stage, but none of the experiments which had burdened their original Block I Apollo 2 mission two years earlier. Despite the fact that this was a Block II spacecraft, the mission flown was a revised version of the Apollo 1 mission intended for the Grissom crew. The flight finally qualified the CSM for manned operations and was deemed to be "101% successful."

In addition to their crew support roles on the flight of Apollo 7, Evans, Pogue and Swigert also served on Mission Control Center (MCC) shifts as Capcom – for the three Control Teams led by Glynn S. Lunney (Black team), Eugene 'Gene' F. Kranz (White team) and Gerald D. 'Gerry' Griffin (Gold team) – providing the voice link between the ground team and the crew in space. While Capcoms were usually members of the astronaut team, working closely with fellow astronauts on the flight crew during training, the camaraderie between them could sometimes be tested during shifts on the console.

The Apollo 7 crew came in for a good deal of criticism both during and after the flight, over their attitude and some remarks made while on orbit, but overall, they proved to be more than competent and very professional in carrying out a thorough test flight of the fully-modified Apollo spacecraft. Certainly there was a little testiness at times, but much of this had to do with unwelcome pressure exerted on the crew to conduct additional tests, relayed from the ground. At one stage in the final 48 hours of the flight, on orbit 134, Wally

Schirra blew up when yet another new test was thrust upon the crew: "I wish you would find out the idiot's name who thought up this test," he radioed to the ground. "I want to find out, and I want to talk to him personally when I get back down." During that same orbit, he told Mission Control: "I've had it up here today. From now on, I'm going to be an onboard flight director for these flight updates. We're not going to accept any new games… or doing some crazy tests we never heard of before. Each test is going to be reviewed thoroughly before we act on it." **[28]**

Flight Director Gene Kranz recognized that unexpected pressure was being placed on the crew through these unscheduled tests, but he remained unapologetic. "We really put the spacecraft through its paces," he later admitted. "We had a single flight test to do it, and… we kept piling a lot of stuff on Wally, because with only one test to get the job done, every time we saw an opportunity… we'd go for it; we'd press it; we'd try to get some more testing in there." **[29]**

There was another testy exchange between Schirra and Mission Control, when he informed them that the crew would go through re-entry with their helmets off. He argued that sinus pressure from their colds (although he was the only one really suffering badly from a head cold) might lead to burst eardrums. He said they should be allowed to pinch their noses and blow to equalize the build-up of pressure. Capcom Deke Slayton radioed to Schirra that their helmets *must* be worn for safety reasons. The mission voice transmissions went as follows:

Deke Slayton (CapCom): Okay. I think you ought to clearly understand there is absolutely no experience at all with landing without the helmet on.
Schirra: And there no experience with the helmet either on that one.
CapCom: That one we've got a lot of experience with, yes.
Schirra: If we had an open visor, I might go along with that.
CapCom: Okay. I guess you better be prepared to discuss in some detail when we land why we haven't got them on. I think you're too late now to do much about it.
Schirra: That's affirmative. I don't think anybody down there has worn the helmets as much as we have.
CapCom: Yes.
Schirra: We tried them on this morning.
CapCom: Understand that. The only thing we're concerned about is the landing. We couldn't care less about the re-entry. But it's your neck, and I hope you don't break it.
Schirra: Thank you, babe.
CapCom: Over and out. **[30]**

An adamant Schirra won the argument. He didn't really care about any possible reprisals, as he was leaving the space agency anyway after Apollo 7. About an hour before re-entry, the crew each took a decongestant tablet, and would report no ear problems at all post-flight. In fact, on later Apollo flights, the crewmembers would re-enter without their helmets on.

Completion of LM Testing

Between October and early November, another series of manned vacuum tests at MSC were completed on the modified LTA-8, similar to the tests that had been conducted earlier in the year. With most of the astronauts busy in other areas as Apollo gained pace, Grumman's consultant pilots Gerald Gibbons and Glennon Kingsley were once again called upon, this time both as primary test crewmembers. This series included five sessions in two test phases, each lasting about 13 hours and conducted in Chamber B at MSC. This time Jim Irwin served as backup crewmember for three of the five sessions and prime for two, including the final run in the series. [31]

Irwin later recalled that these tests were akin to preparing for a mission into space. Each run would involve him and his colleague being wired up with biomedical sensors and then suited up in full Apollo pressure suits, requiring a three hour pre-breathe to purge nitrogen from their system. Inside the Chamber's airlock, the air would be pumped out and then the test crew could proceed to clamber into the LM and start the test. After about 8 hours, they would then climb out, working the process in reverse. "You have to be very painstaking, because if you miss one step you've had it," Irwin wrote in 1973. "You could hurt yourself and ruin the vehicle and zilch the timetable of the Apollo program." In one test, they had to simulate an emergency egress to vacate the chamber as quickly as possible. Irwin put on an oxygen mask and thought he had turned on the oxygen flow, which would have allowed him to exit the vehicle, climb down the front LM ladder and head for the airlock. Instead, he had placed the switch back in the 'OFF' position, isolating his oxygen supply and causing him to pass out as he stood on the LM front porch. Luckily, as he fell down the ladder, the rescue crew were there to catch him, preventing possible serious injury, and were able to take him into the airlock. [32]

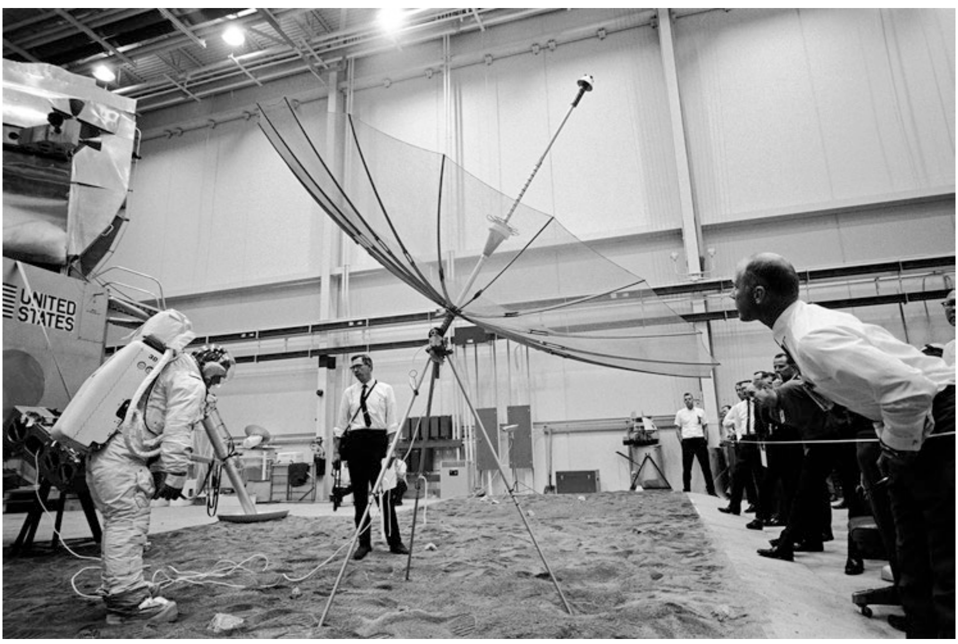
On November 13, NASA named the crewmembers appointed to fly the Apollo 10 mission as Tom Stafford (CDR), John Young (CMP) and Gene Cernan (LMP). [33] Planned for the second quarter of 1969, the F-Mission was the second manned flight of the LM, but retained options to fly an alternative mission, ranging from Earth-orbital to lunar-orbital trajectories. The crew were determined to complete a lunar orbit flight. Thanks to their experience of five flights between them in Gemini, this crew was capable of completing a range of Apollo missions, giving the flight the flexibility to re-run previous profiles or cope with changing plans. A lunar landing was not an option, however, as their LM was too heavy. Fortunately, these alternative plans were not required. The backup crew for Apollo 10 was named as Gordon Cooper (CDR), Donn Eisele (CMP) and Group 5 member Ed Mitchell (LMP). According to Slayton's crewing system, this put them in line to fly as prime on Apollo 13 (H-2 mission). The Apollo 10 support team consisted of LM specialists Joe Engle, Jim Irwin, and Charlie Duke.

On November 14, the day after the Apollo 10 announcement, Irwin and Gibbons clambered into the LTA-8 for the final time, as they simulated lift-off from the Moon and rendezvous with an orbiting CSM. With the LTA-8 series completed, the manned LM missions in space could begin, starting with Apollo 9 in the spring of 1969. [34] Irwin later wrote that he had been informed of his assignment to Apollo 10 by Tom Stafford in the spring of 1968, taking on the support role duties for that mission several weeks before the official announcement. Originally, Irwin assumed that Stafford had meant he wanted him as the backup LMP, probably due to his experience in the LTA-8 tests, but this was not the case. He was to be on the support crew, and his Group 5 colleague Ed Mitchell pulled the backup LMP seat. In this role, Irwin once again found himself spending hours with Grumman technicians in the LM (number 4) that was destined to fly on Apollo 10, thereby becoming a leading specialist in the vehicle.

Apollo 8 then completed its historic mission over December 21-27, 1968, including successfully circling the Moon ten times. The Apollo 8 shift Capcoms were Vance Brand (Clifford E. Charlesworth, Green team), Jerry Carr (Glynn S. Lunney, Black team), and TK Mattingly (Milton L. Windler, Maroon team).

THE FINAL PUSH

On January 9, 1969, the names of the first landing crew – the G Mission – were confirmed as Neil Armstrong (CDR), Mike Collins (CMP) and Buzz Aldrin (LMP), with their backup crew identified as Jim Lovell (CDR), Bill Anders (CMP) and Fred Haise (LMP). For this crucial mission, the support crew consisted solely of CSM specialists, namely TK Mattingly, Ron Evans and Jack Swigert. With Mike Collins restored to flight status, Aldrin had returned to his normal LMP position, unfortunately bumping Fred Haise to the backup crew but leaving him still in line for a mission (Apollo 14, the H-3 mission). Bill Anders had indicated that he would be leaving NASA shortly after the Apollo 11 flight and since he would not be rotating to Apollo 14 with Lovell and Haise, Deke Slayton assigned TK Mattingly, essentially as a second backup CMP. Over the previous three years, Mattingly had worked tirelessly on helping to qualify the Apollo pressure suit and life support system and had become a respected CSM specialist. His reward was this assignment.



Don Lind demonstrates surface activities planned for the first lunar landing. At far right, Apollo 11 LMP Buzz Aldrin looks on intently.

On January 29, in Building 9 at MSC, Don Lind conducted a simulated deployment of the EASEP that had been substituted for the full ALSEP on Apollo 11 due to the limited time the astronauts would be on the surface. Apollo 11 LM Pilot Buzz Aldrin watched the progress of the simulation intently, as it would be his job to deploy the instruments on the lunar surface in less than six months' time. [35]

Though most attention was on the pending Apollo lunar landing missions, work continued on the other programs, especially the Apollo Applications Program (AAP). In February 1969, a ten-day CSM design review for AAP was held at North American Rockwell in Downey, California. As an indication of the seriousness of the review and the commitment to the OWS, Walt Cunningham, scientist astronauts Joe Kerwin and Ed Gibson, and Group 5 astronaut PJ Weitz attended the review as part of a large contingent of 245 NASA and support contractor personnel. Included in this review was a series of meetings and briefings involving mockup displays, designed to evaluate the progress being made on various aspects of the OWS design and mission planning. [36]

The return of the 'Icy Commander'

On May 16, 1969, MSC *Roundup* reported that after a hiatus of six years due to an inner ear disorder, America's first astronaut and current Chief of the CB, Alan B. Shepard (misspelt as 'Shepherd' in the article!), had been fully restored to solo aircraft flying and spaceflight status. His ailment had been corrected by surgery the previous year. Shepard, it was stated, would remain as Chief Astronaut until he was assigned a flight, adding that it had taken the astronaut nine months to regain his full flight capability. Hoping to be assigned to one of the Apollo Moon landings, a typical reported quote from Shepard was: "the sooner I get off the ground the better." [37]

Prior to this, starting on March 3, 1969, the Apollo 9 mission flew for ten days in Earth orbit, qualifying the CSM/LM combination and Apollo EMU pressure garment. Supporting the mission from Mission Control were Capcoms Evans, Lousma, Roosa and Worden, working with the MCC controller shifts of Gene Kranz (White team), Gerry Griffin (Gold team) and Pete Frank (Orange team).

The following month, Don Lind returned to evaluating the planned surface activities of Apollo 11, serving as a test subject to examine the most appropriate method for walking on the Moon in one-sixth gravity. On April 10, with Apollo 11 still three months away, optimism for success was riding high when the second landing crew of Pete Conrad (CDR), Dick Gordon (CMP) and Al Bean (LMP) was named to Apollo 12. Bean had been assigned to this crew-in-waiting following the death of the original LMP, C.C. Williams, in a T-38 crash in October 1967. The backup crew consisted of Dave Scott (CDR) and two Group 5 astronauts, Al Worden (CMP) and Jim Irwin (LMP). At the time of the announcement, a support crew had not been finalized, but were subsequently chosen as Ed Gibson, the first Group 4 astronaut to receive a support role, PJ Weitz (CM specialist) and Jerry Carr (LM specialist). The H-1 mission of Apollo 12 was expected to fly four to six months after Apollo 11 and would include two periods of EVA, totaling over 5 hours, at a different landing site. It would also include the deployment of the first complete ALSEP. [38] What was not acknowledged at the time was that the backup crew would be in line to fly Apollo 15, the fourth and final mission of the H-series, in 1970. For Worden and Irwin, the possibility of a flight to the Moon was becoming very real.

Being so close to success after eight long years meant the pace to reach the Moon was not slowing down. From May 18 to 26, Apollo 10 flew the fourth manned mission, again a highly successful one. For the second time, a manned American spacecraft reached lunar orbit, this time to evaluate the performance of the LM down to within 9.7 miles (15.5 km) of the surface, before deliberately terminating the descent and heading back to rendezvous with the CSM. Capcoms on this mission were Carr, Duke, Engle, Irwin, Lousma and McCandless, working on the Mission Control shifts of Gene Lunney (Black team) Gerry Griffin (Gold team), Milt Windler (Maroon team), and Pete Frank (Orange team)

The next month brought the surprising news that the USAF had abruptly cancelled its MOL program, leaving Apollo as the only operational American manned space program.

The Greatest Week

Between July 16–24, the world watched as the Apollo 11 astronauts achieved the historic first human contact on a celestial body other than Earth, a fulfillment of the first half of President Kennedy's commitment to land men on the Moon. They completed the late president's challenge by returning home again safely. There were five months to spare[1].

The Capcoms assigned to this mission included Charlie Duke, who was on console for the historic landing sequence, Joe Engle, Ron Evans, Don Lind, TK Mattingly and Bruce McCandless, who worked console as EVA Capcom during the surface activities. Each of these men had worked tirelessly for three years in support of important aspects of Apollo procedures, systems and hardware, and continued this association with the flight control teams of Cliff Charlesworth (Green team), Griffin (Gold team), Kranz (White team), Lunney (Black team) and Windler (Maroon team) in the MCC.

From the Moon, science

Despite successfully achieving the manned lunar landing at the first attempt, the momentum of Apollo did not slow. Progress towards the second landing mission, Apollo 12, was well advanced, but there was a call for the interval between the landings to be extended, so that the results from one mission could be analyzed – and any lessons learned applied – before flying the next one, stretching out the manifest into the early 1970s.

By August 1969, a further nine landings remained firmly in the plans for the mainstream Apollo lunar program. On August 6, with the Apollo 12 (H-1) crew in training, NASA named the crews for the Apollo 13 (H-2) and 14 (H-3) missions, planned for the first half of 1970. [**39**] At the time, the landing sites had yet to be announced, but it was stated that each mission would include a surface stay time of no more than 35 hours. This would include two periods of EVA foot traverses, each approximately 3 hours, and a full ALSEP deployment. This announcement also saw the first members of the 1966 selection formally identified as being assigned to Apollo prime crews.

[1] In reality, the 'end of the decade' in President Kennedy's speech of May 1961 was not December 31, 1969, but December 31, 1970, though generally it was taken to mean the end of the 1960s. If taken literally as the end of 1970, then America made it to the Moon with 17 months to spare.

Charles Duke, Capcom during the Apollo 11 descent, with Lovell and Haise closely monitoring events. [Inset] McCandless (center), Apollo 11 lunar surface Capcom, with Duke (left) and Engle. (Courtesy Ed Hengeveld).

The Apollo 13 prime crew was named as Jim Lovell (CDR), alongside two Group 5 astronauts, TK Mattingly (CMP) and Fred Haise (LMP). Their backups were named as John Young (CDR) and another brace of Group 5 astronauts, Jack Swigert (CMP) and Charlie Duke (LMP). The three-man support crew also came from the 1966 selection, with LM specialist Lousma named with CSM specialists Pogue and Brand. Group 6 scientist astronaut Tony England was named as Mission Scientist, with Group 4 scientist astronaut Kerwin as lunar EVA Capcom. The new position of Mission Scientist had been introduced due to the increasingly geological and scientific nature of the subsequent landing missions. The Mission Scientist would serve as a coordinator between the crew on the lunar surface, the Flight Director and his team, and the scientific community in the support rooms at Mission Control. It was another role that extended into the OWS (Skylab) program through 1974.

The Apollo 14 crew included Alan Shepard as CDR, with his crew once again comprising two of the rookie 1966 astronauts; Stu Roosa (CMP) and Ed Mitchell (LMP). Their backup crew consisted of Gene Cernan (CDR) and Group 5 astronauts Ron Evans (CMP) and Joe Engle (LMP). At this point, no support crew was named, but they were subsequently reported to be Group 6 scientist astronaut Phil Chapman (Mission Scientist), Bill Pogue (CMP)[2], and Bruce McCandless (LMP).

[2] Pogue was subsequently replaced by Group 7 astronaut Gordon Fullerton, after he moved across to Skylab training following the cancellation of Apollo 19.

The Apollo 13 and 14 crewing saga

In November 1967, Deke Slayton had 18 astronauts assigned to the first three missions as either prime or backup, thus providing the core of the first six flights with the three backup crews flying the fourth, fifth and sixth mission. These crews would train for and fly the critical test missions to evaluate the hardware and procedures leading to the first landing, hopefully by the sixth mission. Slayton informed the astronauts that the crews might not stay intact or in the same order, but, with very few changes, this is how the schedule developed to the end of 1969 when the backup crew for Apollo 9 flew as the prime crew on Apollo 12.

With the landing goal achieved and more than enough astronauts to fill the seats available, Slayton could now be more selective in choosing future crews, aimed at specific missions rather than to support the development of hardware and procedures. Much has been written about the original crewing of Apollo 13 and 14, and about various astronauts turning down the opportunity, or being overlooked by Slayton. He instead assigned rookie Group 5 astronauts Stu Roosa and Ed Mitchell from the Apollo 10 backup crew to the Apollo 13 prime crew, under the command of Chief Astronaut Alan Shepard following his return to flight status. In fact, this trio had been announced internally within the Astronaut Office as early as May 1969. Shepard would not be denied his chance to fly to the Moon, and controversially bumped an outraged Gordon Cooper from his expected role as mission commander, which eventually led to Cooper's resignation from NASA. Identified as potential backups, who would in turn rotate to fly Apollo 16, were John Young (CDR), Gene Cernan (LMP) and rookie Jack Swigert (CMP), who had proven himself in his support work roles since 1966. Twice-flown Cernan turned down the chance to fly as LMP again, holding out for a commander's slot. At the time this was a huge gamble, as there were very few flight seats left. Cernan's replacement as LMP was another stalwart of support and Capcom assignments, Charlie Duke.

At the same time, with flights only three months apart, Slayton looked at the backup crew of Apollo 11 to fly Apollo 14, choosing Jim Lovell (CDR) and Group 5 astronauts TK Mattingly (CMP) and Fred Haise (LMP). Gene Cernan's gamble soon paid off, as he was provisionally assigned as backup CDR for Apollo 14, along with Group 5 rookies Ron Evans (CMP) and Joe Engle (LMP). Engle had apparently been told of his assignment to Cernan's crew in June. The three men could then expect to fly as the prime crew of Apollo 17 in 1971.

That was Slayton's plan, but higher management blocked the idea of Shepard's crew flying so soon after Shepard's return to flight status. With just over six months available to train for a complex mission, Shepard's lack of spaceflight experience reinforced their argument, having only a 15-minute suborbital flight eight years earlier. Faced with this, and with no option to complete a major review of crewing or delay the mission for a year, Slayton decided to swap the prime crews, offering '13' to Lovell and giving '14' to Shepard. This is how the assignment read when released in August, to the obvious disappointment of Shepard and his crew at their delay, and the enthusiastic anticipation of the Lovell crew of flying early. No one could have anticipated the dramatic events that would capture the attention and prayers of people around the world, as Lovell's Apollo 13 crew fought against overwhelming odds for their very survival.

More from MOL

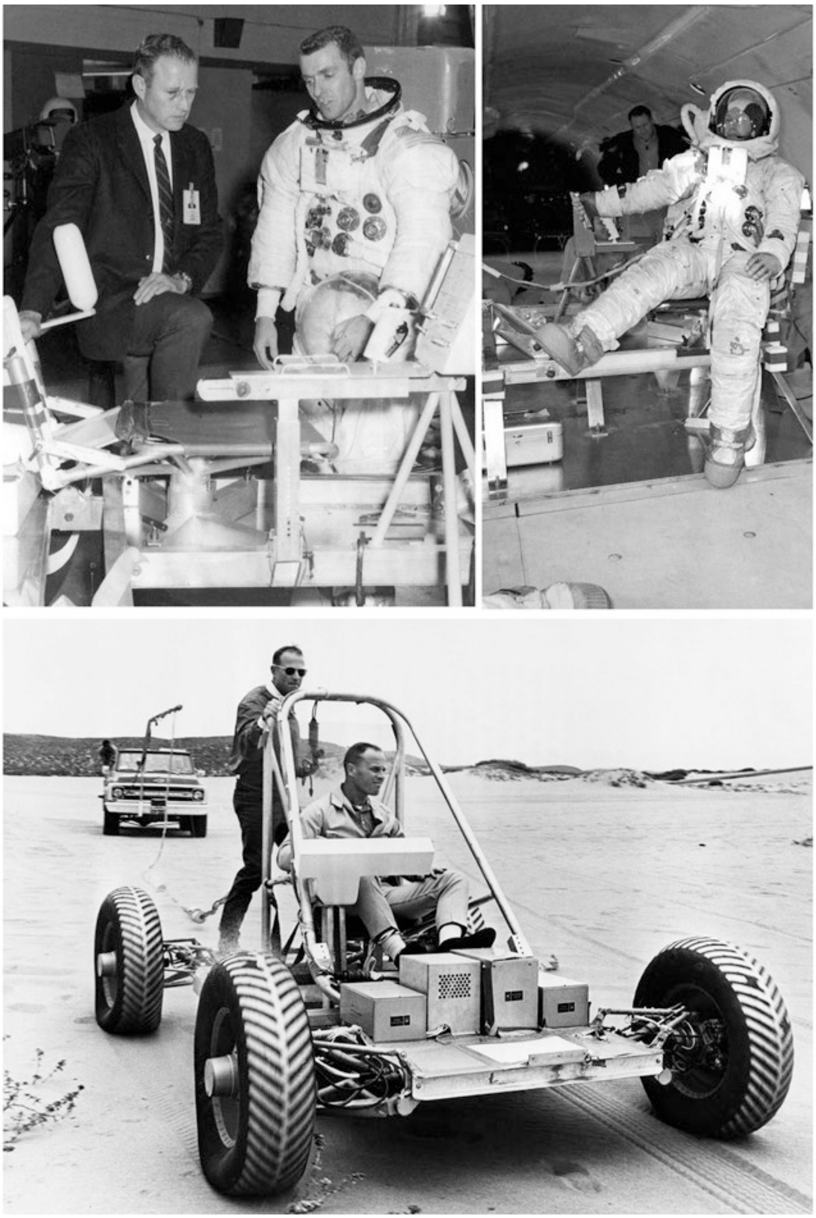
Just one week after the announcement of the Apollo 13 and Apollo 14 crews came the news, on August 13, that seven former MOL pilots were transferring to NASA as fully-fledged astronauts [40]. The announcement noted that an effective date of their new assignment had not been set, but their inclusion had brought the total number of active astronauts at MSC to 54. The August 22, 1969 edition of MSC *Roundup* highlighted the appointment of the seven former MOL astronauts to the NASA astronaut program on the front page, together with news of an eighth former MOL astronaut, Lt. Col. Albert H. Crews, who had been too old to join the Astronaut Office and was subsequently assigned to the Flight Crew Operations Directorate (FCOD) at MSC. [41] The report also noted that three of the new astronauts, Karol Bobko, Henry Hartsfield and Donald Peterson, would complete graduate degrees before assuming their new duties at MSC, sometime during 1970. Meanwhile, the four who had decided not to continue their formal education, Robert Crippen, Gordon Fullerton, Robert Overmyer and Richard Truly, would make the move to MSC for astronaut duty in September.

On September 22, 1969, new Chief of the Astronaut Office, Tom Stafford (who had replaced Al Shepard now he was training for Apollo 14), issued a memo detailing AAP assignments within the Astronaut Office. [42] Interestingly, scientist astronauts from Group 4 and 6 filled most of the appointments, with Walt Cunningham heading the Branch Office assisted by his Apollo 7 and Group 3 colleague Don Eisele. Only Don Lind and Bruce McCandless were represented from the 1966 selection, with all the other fifteen members of Group 5 assigned to the mainline Apollo program and none of the newly arrived Group 7 astronauts listed. Things would change quickly over the next twelve months.

The four Group 7 astronauts who did arrive at MSC were soon absorbed into the Astronaut Office activities, as outlined in a November 25, 1969 memo from Thomas McElmurry, Technical Assistant for Advanced Planning, at MSC Code CA, FCOD, listing astronauts and other personnel who would participate in a FCOD AAP 'Cluster' Review at MSFC between December 2–4. In the listing, Bob Overmyer's technical role was given as Structures, and Al Crews, while not an astronaut, was listed as supporting HSS/Crew Systems. [43]

Interestingly, a second article in the same edition of *Roundup* outlined a recent testimonial on the future of the Apollo program by George E, Mueller, the Associate Administrator for Manned Spaceflight. [44] Testifying before the Senate Committee on Aeronautical and Space Science, Mueller revealed that Apollo 12 would be targeted for Landing Site 7 in the Ocean of Storms, possibly close to the Surveyor III spacecraft. This robotic spacecraft was the second spacecraft in the Surveyor series to achieve a successful soft landing on the Moon. It was placed there in order to support the later manned Apollo landings, by developing and validating the technology for landing softly on the Moon, providing data on the compatibility of the Apollo design with conditions encountered on the lunar surface and adding to the scientific knowledge of the Moon. [45] Mueller also noted: "Apollo 13 would be targeted for the highland region near the Fra Mauro formation; Apollo 14 to the highlands near the crater Censorious; Apollo 15 to the Littrow area characterized by dark volcanic material; Apollo 16 to crater Tycho, site of the Surveyor VII landing; Apollo 17 to the Marius Hills region with its many volcanic domes; Apollo 18 to Schroter's Valley to scout possible transient events and red flares sighted in the area; Apollo 19 to the Linear Rille to determine whether or not it is [of] volcanic origin; and Apollo 20 to the crater Copernicus to examine deep-seated material ejected from when the crater was formed."

Mueller also explained how improvements to the astronauts' spacesuits and the PLSS were underway, as well as modifications to extend the LM surface stay time and make the spacecraft more habitable while on the Moon. **[44]** At this point, the future of Apollo looked quite promising for the astronauts hoping for assignment to these upcoming



Three images of Jerry Carr, with Joe Engle (top left) and Jack Lousma (bottom), during the development and testing of the Boeing Lunar Roving Vehicle. (Courtesy Ed Hengeveld) missions. Early reports from the Apollo 11 astronauts had indicated that working on the Moon was preferable to weightlessness or Earth gravity, and that mobility was better than anticipated, while their whole experience on the surface was "a pleasant period." The primary difficulty was the lack of time to complete everything that Armstrong and Aldrin wanted to get done. The astronauts did reveal that when the window shades were drawn, the temperature inside the LM cabin dropped to a point where it became a little uncomfortable, making sleeping difficult. To address these concerns, amendments to the LM, the surface equipment and procedures for subsequent landings would improve the comfort of the crews and afford them more time to complete their objectives. This, of course, would be dependent upon funding authorization to complete the planned nine landings.

Those landings were being planned to include journeys much further from the LM than the foot traverses were capable of achieving. There had been a number of transportation devices proposed over the years, ranging from small, single-seat flying platforms to full-scale mobile laboratories. As an initial mobility aid, a two-wheel Mobile Equipment Transporter (MET) hand cart was being developed for Apollo 14 through 16, which would be followed by an unpressurized two-man jeep-like roving vehicle, used from Apollo 17 onwards, that could be folded up on the side of the LM descent stage and deployed by the crew on the surface. On October 28, 1969, Boeing was chosen as prime contractor for the Apollo Lunar Roving Vehicle (LRV) and astronauts Jerry Carr, Joe Engle and Jack Lousma received a fresh technical assignment to represent the Astronaut Office in the development of the LRV. This involved working with Boeing engineers to test and evaluate the system prior to its initial flight on the second of the J-series 'super-science' missions (Apollo 17).

Apollo 12 flew between November 14–24 and completed a lunar landing on the Ocean of Storms. What was remarkable on this mission was LM *Intrepid's* pinpoint touchdown, which placed the crew within walking distance (1180 ft./360 m) of Surveyor III. Apollo 12 also saw the first deployment of ALSEP. The Capcoms on this flight were Jerry Carr, Jim Irwin, Don Lind, PJ Weitz and Al Worden, who worked with the MCC teams of Griffin (Gold team), Frank (Orange team), Charlesworth (Green team) and Lunney (Black team).

By December, all the attention had turned to Apollo 13, scheduled for launch in the spring of 1970. Just prior to Christmas, between December 17–20, a group of astronauts completed a geological field trip to the island of Hawaii. The group included Lovell and Haise, their backups Young and Duke, and support crewmembers Jack Lousma and Vance Brand. While in Hawaii, the crew observed a small eruption of a new volcano vent on the Chain of Craters road. Ten days after the astronauts had witnessed this very minor eruption, a dramatic second event sent lava cascading about 1600 ft. (487.68 m) into the air. [46]

Apollo's future in doubt

While 1969 will be remembered as the year that humans were no longer restricted to the Earth, as the Moon became the first celestial body within our grasp, for the members of the Astronaut Office, especially those from the latter groups yet to fly, the prospect of further landings, multiple OWS and new projects on the horizon seemed hopeful. But the year would also be remembered as the beginning of the dissolution of NASA's grand future plans at the very height of Apollo's success, the very foundation upon which those plans should have been built.

As the year ended, rumors persisted that pending cuts in the NASA budget would cause the axe to fall on the later Apollo missions, in favor of diverting the spending to a larger space station than the Saturn OWS, and to a new program called Space Shuttle. The *Washington Post* for December 28, 1969 reported that the final Apollo mission would likely be Apollo 16, not Apollo 20, and that there were no plans to return to the Moon for some time afterwards.

It is ironic that the very moment where the eight-year struggle to get to the Moon had been achieved, not once but twice, was the point at which the infrastructure to continue the exploration failed to be established and secured. As Wernher von Braun once commented, by reaching Earth orbit you were halfway to anywhere in the solar system. On the eve of the Apollo 11 mission, the eminent German scientist had foretold that if Apollo, at the height of its success, was to be cancelled and the Moon abandoned after the first landings, the decision would be looked upon in history as a grave error. Almost 50 years after that statement and the historic mission which followed, it seems that he was right.

CHASING DREAMS

Around the time of the first lunar landing, there was much speculation and reports in the media of a grand future for human space exploration. The articles and illustrations portrayed an almost idyllic space program, with dozens of launches, huge space bases, extended operations on and around the Moon, and human exploration of Mars and beyond, all within a generation or two. Almost 50 years later, the world is still waiting for the realization of that dream, and for missions which should have been crewed by members of the Class of 1966 in the 1970s and 1980s, but which got no further than the papers they were printed on.

What happened? Over the ensuing decades, dozens of articles, debates and, more recently, countless postings on social media and the World Wide Web, have pointed to a fear of losing a crew on the Moon, the lack of clear competition from the Soviets, budget restrictions, the expensive and ultimately futile conflict in South East Asia, unrest at home, a desire to develop the Space Shuttle, and satisfying the needs of the USAF. All of these are certainly contributing factors in the larger picture. But the key to the success – and indeed the demise – of Apollo, was the availability of its hardware to support the missions beyond the initial lunar landing, notably the Saturn V. The fate of Apollo was perhaps already sealed by the desire and commitment to strive for the Moon within a decade, without having a sound plan in place for what to do next.

Limited production

In 1962, NASA decided to opt for Lunar Orbit Rendezvous (LOR) as the primary method to reach the Moon within a decade. It was determined that it would take 15 Saturn Vs to accomplish the manned lunar landing goal by 1970, so the primary fabricators of the three stages – Boeing, North American Aviation and McDonnell Douglas – received contracts sequentially in batches. The final order, covering AS-513-515, came on February 3, 1967, and with it, the mandate officially sanctioned by Congress was fulfilled.

By 1967, AAP was progressing slowly, supported by trickles of funding, with hopes that it would eventually be fully funded to follow on from mainline Apollo. Mindful of this, NASA requested an extension to operations in its budget request for FY1968 and, on July 26, 1967, issued long lead contracts for the fabrication of AS-516 and AS-517 to support AAP operations. They would turn out to be the only items of dedicated AAP hardware ordered from scratch. The stumbling block to further expansion beyond 1970 was that the request fell in the summer of 1967, just when NASA was recovering from the Apollo 1 pad fire. Hopes of purchasing more CSMs were dashed, forcing NASA to look at flying refurbished flown CMs in the hope of keeping AAP alive alongside all the planned lunar missions. All extended operations involving the LM on AAP missions ended, and while planning for non-landing AAP missions continued, it would only be with refurbished spacecraft unless the Apollo flights were trimmed. At this point, all hopes of surface-based AAP operations ended, and the construction of AS-516 and -517 progressed no further than the paper the long lead contracts were written on.

Though hardware for missions beyond Apollo was effectively terminated in 1967, this did not stop the publication of documents and reports about what NASA was *hoping for* beyond 1970, with little confidence of receiving the funds to meet the plans, and certainly with no new Saturn V hardware beyond that proposed five years previously. With a new group of pilot astronauts completing their training, and a second group of scientist astronauts arriving in the fall of 1967, it is not surprising that Deke Slayton quite openly told them they would not be needed, and that if they stayed they could expect a long wait for a ride into space. Despite what was bouncing around in the media, that ride would almost certainly not be on a Saturn V.

The problem was exacerbated by several publications promoting the opportunities afforded by flying the AAP missions, as well as developing an advanced Block III CSM, a fleet of lunar exploration flying platforms, and mobile laboratories to conduct extended sojourns across the lunar landscape. Writers reported all this as the potential follow on to the ten authorized lunar landings, generating enthusiasm for an aggressive and sustained program *after* Apollo had achieved President Kennedy's goal. Even Congressional hearings at the time included presentations and debates on the future of lunar exploration after Apollo. The stark reality, however, was that there was no funding for such a program and no orders issued to produce the hardware to support it. **[47]**

In January 1969, a new administration entered the White House, and everything went awry. At first, at least outside NASA, there was little noticeable difference. But, as notable space historian Dr. David Baker observed, "President Richard Nixon was paranoid about a disaster and never signed to protect [the existing] Apollo missions, even asking for a restructuring plan to cancel missions after Apollo 14." **[48]** Fortunately, Nixon was talked out of that plan, but despite the publication of several reports in the latter months of 1969 detailing expanded lunar exploration, there was a distinct lack of interest in the White House and on Capitol Hill for such ideas. Instead, with the support of the Air Force, the decision makers elected to move on from the production of the one-shot Saturn V and endorse the Space Shuttle. By the end of 1969, Apollo was old news, and had begun to lose air time on the national TV channels, just when the exploration was becoming more interesting. The TV equipment flown on Apollo, while basic by modern standards, was state of the art in its day, but a camera failure on Apollo 12, the abort of Apollo 13, and the static cameras on Apollo 14 did little to portray the adventure, historical significance and sheer excitement of exploring a new world. Even as late as 1972, there was a fear of shortening the odds of possible failure by continuing to send men to the Moon. The slip of the Apollo 17 launch window to December, a month after the 1972 presidential election, was partly in fear of the impact a disastrous mission to the Moon might have on Nixon's re-election campaign.

Death of a thousand cuts

There was no official 'end' to the Saturn V story, though in reality the demise of the monstrous launch vehicle began even before the first one left the launch pad. The closest date to an 'official' termination of production came with the February 3, 1967 order to produce the final three Saturn Vs. But for the next several years, into the 1970s, NASA still produced documents, graphs and charts portraying plans for further hardware, for which no contracts were ever written or signed, nor budgets allocated.

In 1972, the same year the NERVA nuclear rocket was terminated, the Space Shuttle was given the go-ahead. Despite Boeing's best efforts to convince NASA to continue using a Saturn V S-IC first stage to launch the Shuttle, the agency opted instead for the SRB/ET/SSME configuration. The final two sets of Saturn V hardware were relegated to museums on December 16, 1976, four years after the final Apollo flew to the Moon, primarily to save on the huge costs of keeping them in storage with no prospect of using them operationally.

All suited up and nowhere to go – for a while

The Group 1 selection of April 1959 was specifically instigated to create a small team of astronauts to fly the one-man Mercury spacecraft. When Apollo was created in 1960 and targeted to the Moon the following year, NASA faced the dilemma of having neither sufficient astronauts to fly the proposed missions, nor the skills or experiences of specific techniques in order to achieve the lunar landing. As a result, Project Gemini was created, as a learning curve program to fly between Mercury and Apollo, and so two more groups of astronauts were chosen in 1962 and 1963 to fulfill the crewing needs of both Gemini and the Apollo missions leading up to and including the first lunar landings.

With support from Congress to reach the Moon by the end of the decade, there was a natural, and indeed logical assumption within NASA and industry that success would generate the interest to do more and go further. To do this, plans had to be made and crews prepared while hardware was being built and funds secured. And that was the fatal error. Documents were prepared and plans proposed to support an expanded and extended program of missions to the Moon and in near-Earth space, using Apollo hardware that had yet to be paid for or built. New astronauts were selected in the second half of the decade to crew missions that were not firmly approved. Two scientist astronaut selections in 1965 and 1967 and a large pilot selection in 1966 were instigated to fulfill this expected demand, but like MOL, these plans never turned into reality. The few former MOL astronauts who decided to try their luck at NASA did so at a bad time, although there did at least exist an outside chance of flying on the final extended scientific missions to the Moon, or to a small pioneering American space station. There was also talk of a possible joint docking mission with the Soviet Union and, in the future, the slim possibility of flying some of the first flights of the Space Shuttle, if they could wait around long enough.

SUMMARY

By December 1969, the Astronaut Office had around 50 active members, most of whom had worked tirelessly to fly, back up and support the missions and the nation's effort to reach the Moon. Shortly after Apollo 11, several of the veteran astronauts from earlier selections made the decision to leave the Astronaut Office and either head into higher management roles or leave the agency altogether. This opened up crewing opportunities on future missions to the astronaut classes chosen between 1965 and 1969.

Despite the ominous rumors of flight cancellations, preparations were continuing to fly Apollo into at least 1972, with four complete crews in training as prime or backup teams for two missions, and two further crews preparing to be named to a third flight in the spring. In parallel to this training, a group of astronauts were supporting developments for the first OWS program in 1973 and its three planned missions of 28, 56 and 56 days. After that, the plan became more uncertain, and within a year the flight opportunities were not looking quite as good. Of the nineteen pilots selected in 1966, seventeen remained in the CB by December 1969. For them, and the seven transfers from the MOL program who were either settling in at MSC or completing their studies, the dawning of the 1970s would signal a new direction in space, and a decision which would affect them all.

References

1. ***But for the Grace of God***, William R. Pogue, Soar with Eagles Publishers, 2011, pp. 207-209
2. NASA News Release, MSC 67-69, December 4, 1967
3. MSC Roundup, Vol. 7 No. 7, January 19, 1968
4. *The Moon-Walkers' New Clothes*, MSC Roundup, Vol. 7 No. 7, January 19, 1968, p. 1
5. LTA-8 Test Report, Man-Rating (Houston, MSC, 1968), 1, JSC-SESL Archives
6. *Apollo Vacuum Chamber Tests: All Dressed Up and No Place to Go,* Ed Hengeveld, Spaceflight magazine (British Interplanetary Society, London), issues March & April, 2000
7. *Crewmen See Mock-up of Orbital Workshop*, MSC Roundup, February 16, 1968, p. 2
8. *Apollo Gulf Exercises Scheduled This Month*, MSC Roundup, March 1, 1968 p. 3
9. *Yo, Ho, Ho, and a Bottle of Marezine*, MSC Roundup, April 26, 1968, p. 8
10. Memo from Alan Shepard to all astronauts and other directorates, May 8, 1968, from the Curt Michel Collection, Rice University, copy in the AIS archives
11. ***Failure is Not an Option***, Gene Kranz, Simon & Schuster, 2000, pp. 227-228
12. ***NASA's Scientist-Astronauts***, Colin Burgess and David J. Shayler, Springer-Praxis, 2007
13. ***Apollo: The Lost and Forgotten Missions***, David J. Shayler, Springer-Praxis, 2002 pp. 173-175
14. Memo from Jack Schmitt, to the "Incredible 5" and the "Original 19," Subject: *Opportunities for proficiency training in geology*, May 14, 1968, from the Curt Michel Collection, Rice University, copy in the AIS archives

15. *Crew Enters Apollo 2TV-1 For Seven Day Vacuum Test*, MSC Roundup, Vol. 7 No. 18, June 21, 1968, p. 1; also, *Successful Apollo 2TV-1 Test called "Significant Milestone,"* MSC Roundup, Vol. 7, No. 19, July 5, 1968, p. 1
16. MSC News Release, MSC 68-38, May 24, 1968; also, *LTA-8 Chamber Test "Unqualified Success,"* MSC Roundup, June 7, 1968, p. 3
17. *CSD to Test 1st Apollo PLSS Today*, MSC Roundup, June 21, 1968, p. 4
18. *MPLSS for Apollo EVA Gets Vacuum Checkout*, MSC Roundup, Vol. 7, No. 19, July 5, 1968, p. 4
19. ***Astronautics and Aeronautics***, NASA publication SP-4010, 1968, p. 113
20. *Victoria Advocate*, Texas, July 17, 1968
21. *Health Forces John S. Bull to Quit Astronaut Program*, MSC Roundup, Volume 7, No. 20, July 19, 1968, p. 1
22. *Spinal Growth Forces Collins to Leave Third Apollo Crew*, MSC Roundup, Vol. 2, No. 21, August 2, 1968
23. MSC News Release, MSC 68-60, August 8, 1968; also, *Lovell to replace Collins on Third Apollo Crew*, MSC Roundup, Vol. 7, No. 22, August 16, 1968
24. Philip Baker, "Science, and a Little Golf," from ***Footprints in the Dust*** (ed. Colin Burgess), University of Nebraska Press, Lincoln, NE, 2011
25. ***Don Lind, Mormon Astronaut,*** Kathleen Maughan Lind, Deseret Books, 1985
26. ***To a Rocky Moon***, Dion E Wilheims, University of Arizona Press, 1993, pp. 192-193
27. *NASA Terminates H-1 Production*, MSC Roundup, Vol. 7, No. 24, September 13, 1968, p. 1
28. *"Those Angry Young Men in Apollo 7," Sydney Daily Telegraph* newspaper, issue November 1, 1965
29. ***In the Shadow of the Moon***, Francis French and Colin Burgess, University of Nebraska Press, Lincoln, NE, 2007
30. Mission communications transcripts, spacecraft-to-ground, Apollo 7, October, 1968
31. *Lunar Module Readied for Chamber Testing*, MSC Roundup, September 27, 1968, p. 4
32. ***To Rule the Night***, James B. Irwin with William A. Emerson Jr., A. J. Holman Company, 1973, pp. 204-205
33. MSC News Release, MSC 68-81, November 13, 1968
34. *LTA-8 Manned Tests Successfully Completed*, MSC Roundup, November 22, 1968, p. 4
35. *EASEP Deployment*, MSC Roundup, January 24, 1969, p. 4
36. *A Spacecraft of All Seasons*, MSC Roundup, March 7, 1969, p. 4
37. *Mercury's Shepherd Rejoins Flight Group*, MSC Roundup, May 16, 1969, p. 4
38. MSC News Release, MSC 69-27, April 10, 1969
39. MSC News Release, MSC 69-56, August 6, 1969
40. MSC News Release, MSC 69-58, August 13, 1969
41. *Orbiting Lab Pilots Assigned to MSC Group*, MSC Roundup, Vol. 8, No. 22, August 22, 1969
42. Memo from Thomas Stafford, dated September 22, 1969, Subject: *AAP assignment within the Astronaut Office*, copy in the AIS archives
43. Memo signed by Thomas U. McElmurry, Code CA, Subject: *FCOD participation at AAP Cluster Review*, November 25, 1969, copy in the AIS archives

44. *Mueller Outlines Future Apollo Lunar Objectives*, MSC Roundup, August 22, 1969
45. NASA Space Science Data Coordinated Archive, available online at: http://nssdc.gsfc.nasa.gov/nmc/spacecraftDisplay.do?id=1967-035A. Last viewed November 29, 2016
46. *Apollo 13 crew – Modern Day '49ers?* MSC Roundup, January 16, 1970, p. 4
47. ***Apollo: The Lost and Forgotten Missions***, David J. Shayler, Springer-Praxis, 2002
48. Email from David Baker to David J. Shayler, December 23, 2016

7

Preparing for MOL

"Upon assignment to a specific orbital flight, the primary and backup crews will commence 12 months training as prescribed by the formal Preflight Training Plan."
Taken from the MOL flight crew training description, MOL Program Plan, Volume 1, June 15, 1967

While NASA's nineteen new astronauts were settling into their training in Houston, the first two classes of Manned Orbiting Laboratory (MOL) astronauts were progressing through their own preparation program. Based in California, the MOL training program bore similarities to that of NASA, with academic work on the basics of spaceflight, briefings on the hardware and systems, and various survival courses, though the primary objectives of each program were very different.

The highly visible and, on the surface, scientifically-orientated *civilian* Apollo lunar program was in stark contrast to the largely secretive and clandestine activities to prepare the MOL astronauts for their missions in Earth orbit. For over half a century, details of the program remained classified, and with it details of the crew training program. Over the years, snippets of information emerged, but in 2015 a significant amount of documentation on the program became declassified and was released. It is from these documents that some of the crew training program for the MOL astronauts group can be pieced together.

In issuing a call for prospective MOL pilots, as explained earlier, the USAF had set out some basic qualifications, which resembled the NASA criteria issued at the same time. Each MOL applicant had to be a U.S. citizen, no more than six feet tall, born after December 1, 1931, and a graduate of a service academy, or have achieved a bachelor's degree in the engineering, natural science, physical science, or biological science disciplines. In addition, the applicant had to pass appropriate military physical examinations. Civilians were not permitted to apply, as the candidate had to be a serving member in the

D.J. Shayler, C. Burgess, *The Last of NASA's Original Pilot Astronauts*, Springer Praxis Books, DOI 10.1007/978-3-319-51014-9_7

USAF, USN or Marines. No applications from the Army were sought at this time. MOL required test pilots from the jet fighter community, and later opened the selection to multi-engine pilots, and no Army pilot could have met the selection criteria. There would not be an Army candidate selected for astronaut training until Robert Stewart was chosen among NASA's Group 8 selection in 1978. Each of the 17 officers selected in the three MOL groups (eight in November 1965, five in June 1966 and four more in June 1967) were required to have graduated from the Aerospace Research Pilot School (ARPS) at Edwards Air Force Base (AFB), in California. This program included special courses in advanced astrodynamics and many hours spent flying simulated space flight profiles. If they had not already gone through this specialist course, which was the case for the third MOL selection, then they would have to do so before embarking on the MOL training program.

Before the MOL training and crew preparation program are explained and compared to the NASA basic training program, a brief review of the origins of the ARPS is warranted. This school was specially created during the late 1950s and early 1960s to prepare young military pilots (mainly from the USAF) for a potential career in the emerging fields of space technology, operations, or management.

CREATION OF A SCHOOL FOR SPACE PILOTS

The fifteen years following the end of World War II had witnessed dramatic changes and advances in American aeronautics. These developments included the transition from piston-driven propeller aircraft to the latest jet engine aircraft, as well as the emergence of rocket-propelled experimental aircraft which soon broke the sound barrier. With plans for even more revolutionary aircraft on the drawing board, to test the boundaries between air and space – such as the sleek X-15, expected to push the limits of aerospace research towards Mach 6 – the transition from pure aeronautics to the new science of astronautics was within sight. The responsibility for testing these new aircraft to the brink of their operational envelope, and sometimes beyond, was afforded to several key installations across the United States. The USAF focused upon a substantial plot of land around the isolated Muroc AFB, in California's Mojave Desert, [1] recognizable today as the home of the USAF Test Pilot School (TPS) and the birthplace of the legends of test pilots with the so-called *'Right Stuff.'*

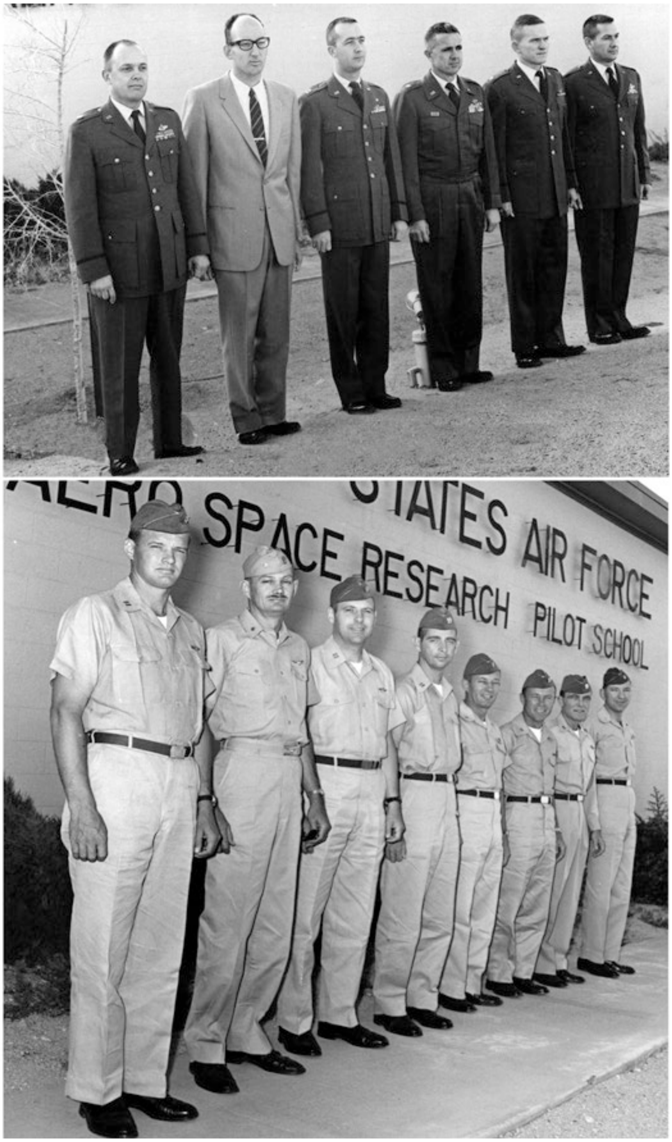
The decision to move the TPS from Wright-Patterson AFB in Ohio to Muroc in California came down to its more favorable all year weather climate, less crowded skies and the sparse population. It also made perfect sense to site the school for test pilots at the same location to which the Air Force had moved its flight test division. The Muroc Dry Lake region covered a remote area of approximately 306,000 acres (65 square miles or 168.3 square km) of semi-arid land within the Mojave Desert, about 100 miles (160 km) north east of Los Angeles. Muroc had been used as a test center for years and was ideally located not only for bombing and weapons training, but also as the center for developing the Bell X-1, which broke the sound barrier in October 1947.

At the end of World War II hostilities, the necessity for training at Muroc abruptly ceased, but with the threat of the new Cold War looming, its capabilities for aeronautical research and development assured its importance. In January 1950, Muroc AFB was renamed Edwards AFB after Captain Glen W. Edwards, who had been killed along with his four crewmembers on June 5, 1948, in the crash of their Northrop YB-49 jet-powered flying-wing bomber. The following year, the Air Force Flight Test Center was relocated to Edwards. [2] In early 1953, the Air Research and Development Command Experimental Test Pilot School at Edwards AFB was renamed the USAF Experimental Flight Test School and so became the focal point for pilots wanting to fly the "hottest and fastest planes in America." It was in this environment that the need for a specialized training course for pilots to ascend to greater heights was recognized and thus the ARPS was born.

The genesis of the ARPS can be traced back to 1959. Barely two years after the success of the first Soviet Sputnik opened the Space Age, contracts were issued for the X-20 Dyna Soar program. With several military and civilian space programs on the drawing board, it was determined that some crucial changes needed to be made to the curriculum at the TPS at Edwards AFB. The X-15 rocket plane was already undergoing flight performance testing there and it became apparent that if the USAF decided to progress with dedicated manned spaceflight operations, then adequately trained military personnel would be required to fill staffing positions, including flight crews.

That same year, future NASA Group 5 astronaut Capt. Edward Givens and his civilian instructor colleague William Schweickhard proposed the concept of a full aerospace course to the school's commandant, Maj. Richard Lathrop. After much deliberation, Lathrop decided there was considerable merit in the idea and in turn asked his special assistant Maj. Thomas McElmurry to get the project up and running. The following year, Maj. Frank Borman joined the group to help 'sell' the idea to the Air Force hierarchy. Despite their enthusiasm and the attractiveness of the proposal, it was by no means a done deal. The group had to work hard to gain support, and progress was not helped by the fact that the USAF did not officially have a manned space flight objective at the time. By the end of the year, however, things were starting to look up, with Air Force Headquarters in Washington D.C. finally approving the course.

The challenges facing the team in setting up the school included the lack of both funding and available course material, which meant it would have to be developed in-house. Compounding these problems, there were very few capable instructors available to learn and then teach the course and precious little suitable space-related training equipment, as nothing like this had been attempted before. Eventually, with help from NASA, universities and several aerospace companies, a basic course structure was devised. The groundbreaking curriculum included thermodynamics, Newtonian mechanics, fluid mechanics and the dynamics of rarified gases, orbital mechanics and bioastronautics. For the first class, a lot of travel ensued as the program was pieced together, with outside vendors located to provide simulators and centrifuge training devices. On top of this, those first 'students' had to teach themselves, with the objective of becoming instructors for the later classes. Many of the graduates from the initial ARPS classes would subsequently become involved in the X-15, X-20 and Lifting Body programs, while others went on to become NASA astronauts and high ranking managers in the USAF space program.



[Top] ARPS Class I (L to R): Lt. Col. Robert M. Howe (ARPS Commandant), William Schweikard (civilian), James McDivitt, Thomas McElmurry; Frank Borman and Robert Buchanan. [Bottom] ARPS Class II (L to R): Albert Crews, Carl Birdwell, Charles Bock, William Twinting, Donald Sorlie, Robert Smith, Robert McIntosh and Byron Knolle (not shown, Arthur Torosian). (Courtesy Space Facts)

On June 5, 1961, the ARPS proposal finally became a reality, with the initial Class I comprising five USAF students – all graduates of the TPS – four of whom were from the school's staff.

ARPS Class I
Maj. Frank Borman
Maj. Robert S. Buchanan
Maj. Thomas U. McElmurry
Mr. William G Schweickhard
Capt. James A. McDivitt from the Edwards Test Operations Division

On October 12 that year, the Experimental Flight Test Pilot School was officially re-designated as the ARPS. It was designed to help Air Force pilots gain the qualifications to become USAF astronaut-designees and, in time, fully qualified military astronauts and potential program managers.

On April 20, 1962, the second ARPS class was announced, with the nine nominated pilots (eight from the USAF and one from the USN) commencing their studies two months later.

ARPS Class II
Capt. Albert H. Crews, Jr.
Lt. Cmdr. Carl Birdwell, USN
Maj. Charles C. Bock, Jr.
Maj. Byron F. Knolle, Jr.
Maj. Robert H. McIntosh
Maj. Donald M. Sorlie
Capt. Robert W. Smith
Capt. Arthur Torosian[1]
Capt. William T. Twinting

The third ARPS class was selected on October 22, 1962. This time, the class consisted of eleven Air Force officers. This class received specific X-20 (Dyna Soar) training as part of their course.

ARPS CLASS III
Capt. Alfred L. Atwell
Capt. Charles A. Bassett, II
Maj. Tommie D. ('Doug') Benefield
Capt. Michael Collins
Maj. Neil R. Garland
Capt. Joe H. Engle
Capt. Edward G. Givens Jr.
Capt. Francis G. Neubeck

[1] Lt. Cmdr. L. N. Hoover, USN, was originally listed to attend this course, but was apparently replaced by Torosian.

Capt. James A. Roman
Capt. Alfred H. Uhalt Jr.
Capt. Ernst Volgenau

The fourth and final designated ARPS class began in May 1963. It consisted of fourteen USAF officers and a single representative each from the U.S. Navy and U.S. Marine Corps.

ARPS CLASS IV
Capt. Michael J. Adams
Capt. Tommy I. Bell
Capt. William J. Campbell
Capt. Edward J. Dwight, Jr.
Capt. Frank D. Frazier
Capt. Theodore C. Freeman
Capt. James B. Irwin
Capt. Frank E. Liethan, Jr.
Capt. Lachlan Macleay
Capt. James S. McIntyre
Capt. Robert K. Parson
Capt. Alexander K. Rupp
Capt. David R. Scott
Capt. Russell J. Scott
Lt. Walter S. Smith, USN
Maj. Kenneth Weir, USMC

Following the fourth class, the original ARPS course became a two-phase test pilot program. Phase I (Experimental Test Pilot Course) and Phase II (Aerospace Research Pilot Course) formed a year-long training program, although contractor and foreign students were limited to the first half of the course due to the specific U.S. military requirements of Phase II. Starting with Test Pilot Class 63A, there would be just two classes each year. The minimum requirements now included at least a bachelor degree in engineering, the physical sciences or mathematics, with greater emphasis on previous academic skills and experience. Most of the candidates for MOL would be shortlisted from the graduates of these courses.

MOL TRAINING BEGINS

Three of the four pilot astronaut selections conducted between 1964 and 1967 were for the MOL program, the first of which was selected in October 1964. Officially announced in November 1965, this group did not start their spaceflight training program until June/July 1966, around the same time as NASA's fifth group of astronauts. These four selection groups were the final exclusively pilot selections of the decade:

MOL I, November 12, 1965 (8 selected)
NASA Group 5, April 4, 1966 (19)
MOL II, June 30, 1966 (5), and
MOL III, June 30, 1967 (4)

[Top] ARPS Class III (Front): Ed Givens, Tommie Benefield, Charles Bassett, Greg Neubeck and Michael Collins. (Back row): Alfred Atwell, Neil Garland, James Roman, Alfred Uhalt and Joe Engle (not shown, Ernst Volgenau. [Bottom] ARPS Class IV (L to R): Schweikard (staff), Robert Parsons, Kenneth Weir, Frank Liethen, William Campbell, David Scott, Alexander Rupp, Michael Adams, James Irwin, Lachlan Macleay, Walter Smith, Russell Scott, Tommy Bell, James McIntyre, Edward Dwight, Arthur Torosian (staff), Frank Frazier, (not shown, Theodore Freeman). (Courtesy Space Facts)

In May 1966, with the first MOL group about to commence its basic training and the second about to be publicly announced, a DoD task force completed its research into the likely usefulness of man in military space programs, together with the positive and negative factors of future MOL objectives. In July, it was reported that the first group of eight MOL astronauts had completed their training, when in fact they had only just started the course. That same month, however, Michael Adams became the first 'military astronaut' to leave the MOL group, replacing recently selected NASA astronaut Joe Engle in the X-15 program. Adams had been offered the seat on X-15 when Engle had made the NASA selection, and viewed it as too good an opportunity to pass up, in part due to the delays in getting MOL training up and running.

What we do know?

The declassified documents released in 2015 give very few details about the training program of the 17 MOL astronauts, nor about when they completed specific phases of their training. Conversely, there are a host of documents explaining the development, objectives and scope of MOL and its systems, as well as basic overviews of projected training plans and training hardware. Due to the covert nature of the MOL program, the astronauts themselves remain tight-lipped about their involvement, beyond anything that has been officially declassified and released. Lachlan Macleay, from the first group of MOL pilots chosen in 1965, would only say: "As far as I'm concerned, nothing has been declassified at all. We spent a lot of time in training, let me put it that way." Another (unnamed) MOL astronaut added: "It is really hard to suddenly slip out of all of this classification that's been built into your psyche for all these years, even though there are things that are absolutely inexplicable near where these gentlemen worked. There is this great big building and it has a big sign in front of it that says the National Reconnaissance Office. And, the first lesson that [an official] gave to me when we were brought in was, 'You never even use the initials NRO.' So, it is a little hard to adjust." [**3**] It may still be some years before the full picture becomes clear.

A shortage of aircraft

One thing that *is* evident from the declassified documents is that it was a struggle to secure adequate aircraft for the MOL astronaut group to use, mainly due to the need to train and supply pilots (and aircraft) for the conflict in south-east Asia.

The MOL Monthly Status Report for October (dated November 1, 1966) noted that there were just two F-104s and a pair of T-38 aircraft at Edwards AFB available to support advanced flight training of the MOL astronauts. There were also two T-29 aircraft at Los Angeles airport and a further five T-38s at Los Alamos Naval Air Station (NAS) for 'space flight readiness training.' In a letter to USAF Headquarters, the Director of MOL thought this was inadequate and emphasized the need for T-38 aircraft to support proficiency training, requesting ten more 'manpower spaces' (aircraft) to support MOL flying operations out of NAS Los Alamitos. A month later, the Status Report for November (dated December 6, 1966) revealed a less than encouraging reply to the request.

Although the HQ staff acknowledged the need for additional resources, the urgent requirement to support combat operations in South East Asia precluded releasing aircraft at that time. However, three T-33s *were* released and sent to Los Alamitos, and two T-38s were reassigned from the ARPS school at Edwards. The consequence of that trade-off was that extended T-38 training in future ARPS classes was cancelled. USAF HQ stated that, apart from these five aircraft, any "follow up action for additional aircraft support is not being considered at this time." This was an early indication of the ongoing struggle MOL would face in providing sufficient hardware and training aids on a limited budget.

Two months later, the MOL Monthly Status Report for January 1967, (dated February 7, 1967) indicated that an Aircraft Support Action Program had been instigated to base all MOL program aircraft at Los Angeles International Airport. This would alleviate the problem of having the aircraft fleet spread across several bases. The MOL aircraft fleet would eventually be expanded, by one T-39 from Space Systems Division, two T-38s from ARPS, and three T-33s from USAF HQ, with the phase-in period for MOL beginning in February 1967.

Keeping the astronauts in the picture

In March 1967, the Group I and II MOL astronauts began a photographic intelligence training program. The two-week program was conducted by the staff of the National Photographic Interpretation Center (NPIC). This program was designed to introduce the MOL astronauts to the field of photographic intelligence, which for many of the pilots was a new skill to master. The first group of four MOL astronauts began the program on March 20, 1967, followed by the second group on April 3. These sessions gave the astronauts initial background briefings in target recognition before they progressed to the Active Target Indicator Mode Selection. [4]

A visit from the Vice President

On July 25, 1967, U.S. Vice President Hubert Humphrey paid an informal visit to the NPIC, where he was introduced to the seven MOL astronauts who were receiving training. During a 12-hour visit to the Center, Lachlan Macleay briefed Humphrey on the planned role of the flight crew during the MOL missions. [5]

The third MOL intake, revealed publicly on June 30, 1967, began their training in September 1967 by attending the ARPS school, from which they would graduate in January 1968. For Don Peterson, this training was "a good fit" at the time, even though, as he admitted, it was a very highly classified program: "Essentially it involved a couple of things that I had experience with. One was flying. They wanted pilots. Also, it involved technical intelligence, and I had three or four years of background in technical intelligence." [6]

Justifying the use of astronauts on MOL was a challenge for the program, especially given the growing developments in unmanned satellite technology and the rising interest in a 'civilian' space station at NASA under the Apollo Applications Program (AAP). A presentation by General James T. Stewart, on September 1, 1967, outlined the perceived abilities of 'Man in MOL,' firstly by suggesting that the astronauts could verify, adjust, or manually control the surveillance equipment by aligning, focusing, pointing, tracking and controlling the exposure; secondly, that the crew would be able to serve as a backup to either failed or malfunctioning sub-systems; and thirdly, that their participation and input would increase the value and quality of the reconnaissance equipment on board the MOL. [7] On October 31, 1967, the Aerospace Corporation released a document in favor of continuing with the Man in the MOL/DORIAN system over a totally automated system.

The MOL 'few' become 'fewer'

The very nature of its program requirements meant that there were only ever a limited number of 'seats' available for the MOL astronauts, whom the USAF preferred to call aerospace research pilots. Therefore, the training group remained small throughout the life of the program (planned for 20, the total number selected was 17). In the closing months of 1967, this select cadre suffered a double tragedy, with the losses of both former Group I MOL astronaut Mike Adams and Group III astronaut Robert Lawrence reducing the ranks still further.

After Adams had left the MOL program to fly the X-15, he made seven free-flights in the rocket-powered aerospace research vehicles. On his seventh flight, on November 15, 1967, he piloted the third aircraft to an altitude of 266,000 ft. (50.4 statute miles), thus qualifying for the USAF Astronaut Wings. But as he achieved that feat, the X-15 went off course and subsequently broke up, crashing in the desert and killing Adams. He was the only direct fatality of the X-15 program. Barely three weeks later came more tragic news from the MOL astronaut group. On December 8, 1967, Robert Lawrence was killed in an F-104 crash at Edwards AFB, California.

The previous day, Don Merkl, an instructor at ARPS and a former contingency selectee for MOL Class III, had flown with Maj. Harvey Royer to perform a check-out 'zoom' flight in the specially modified "dirty lift over drag" F-104 aircraft. On that flight, Royer had made a typical beginner's mistake and had almost crashed the aircraft. To show that the mistake could be overcome, Merkl wanted Royer to attempt a second landing straight away, but at that moment a C-5 aircraft came into their landing pattern. Flight rules prevented the F-104 from flying into possible wake turbulence and, as their aircraft was running low on fuel, Merkl was forced to scrub the attempt and end the training session.

The following day, Lawrence arrived at Edwards to log additional flying time. Merkl had rescheduled a 'zoom' flight with Royer, but upon seeing the schedule, Lawrence had asked Merkl if he could take his place in the back seat. Merkl was at first hesitant, but having "great respect for Lawrence's skills," stepped aside and gave Lawrence the ride. On the fatal approach, Royer badly over-compensated on landing and the F-104 slammed into the runway. The landing gear collapsed and the aircraft caught fire and rolled. Royer, in the front seat, ejected upward but his parachute only partially opened (a 'streamer'). He was seriously injured but survived. Lawrence's ejection seat in the rear was fitted with a slight timing delay to avoid hitting the front seat, so when he ejected from the rolling aircraft, he was hurled sideways, not upward. He was killed instantly. [8]

The active MOL group was now reduced to 15. Just four months later, in April 1968, naval aviator John Finley decided to return to the USN, reducing the MOL cadre to 14, where it would remain until the end of the program a year later.

Countdown to cancellation

As work towards the first manned MOL launch slowly progressed, the astronauts continued to train. During the summer of 1967, the next group of astronauts and support staff attended their two-week NPIC training course. Those who attended again found the course "most favorable [and were] impressed with the caliber of instruction and utility of the curriculum." [9]

Documentation has revealed that astronauts Crippen, Overmyer, Bobko, Fullerton and Hartsfield attended the course starting on July 25, 1967, with Macleay and Truly attending for the morning session only. The previous courses in March and April 1966 had presumably included Adams, Crews, Finley, Lawyer, Neubeck and Taylor. Macleay and Truly were unable to complete the program first time round, which is probably why they attended morning sessions with the second group. Almost a year later, on July 15, 1968, the three remaining Group III MOL pilots, Abrahamson, Herres, and Peterson, began their NPIC course, having been in ARPS training for most of 1967.

Five months prior to the final NPIC MOL course, on February 13, 1968, the group completed an abort simulation program at Ling-Temco-Vought, which proved very useful in gathering basic engineering data and for flight crew training. [10] Very little else has been released concerning their training program.

By January 1969, development of the astronauts' timeline was reported to be progressing well, with several work-rest cycles being evaluated to determine the optimum rotation for the flights. One issue yet to be resolved was that of having both crewmembers sufficiently rested but awake to conduct photographic operations over the target areas, thus sharing the workload. Reading between the lines, single crew operation, or infringements in their sleep, meal and ablution time had caused conflict in the flight planning. Then, during February 4 and 5, the Intelligence Targets for 1971-1973 were defined for MOL crew training, clarifying where, and on what, the astronauts could target their surveillance equipment.

The termination of MOL was probably triggered between March and June 1969, in light of developments in unmanned satellite technology and with the continued debate over the role of astronauts in the program. Several documents (now declassified) argued in favor of Man-on-MOL, debated the automated versus manned argument, and postulated scrapping the program altogether in favor of the new large reconnaissance satellites being developed[2]. On June 8, 1969, in a memo from Secretary of Defense Melvyn R. Laird replying to overriding questions regarding the decision to proceed with or terminate MOL, an important question was raised. That question was whether there could still be some roles for military man in space that could only be determined with actual experience of the person being in space. The answer came back positive, and NASA's experiences tended to confirm this conclusion, but as for ground-breaking new developments which would depend on the presence of a human crew, the memo probably sealed the fate of MOL. It concluded that, "as a result of these experiences, we [the USAF] had not found major

[2] It was the development of these large reconnaissance satellites, with their upper stages, which became instrumental to the Air Force's argument for a larger payload bay for the Space Shuttle in the early 1970s. [11]

new military roles for man in space. Some of the best minds in the country have worked that question for years and I do not feel there are any surprises." That same day, a separate memo was circulated which confirmed the pending termination of the MOL program and included a note that "all crew training is to be suspended."

MOL is cancelled, but the spirit lives on

While the MOL program had been cancelled, it would be wrong to assume the efforts put into the program were totally wasted. In any program, a considerable amount of knowledge and experience is gained, even if it does not progress to its operational phase. For the MOL astronauts, the training program gave, or enhanced, skills and experience that would be useful in their future careers. Many of those involved in the MOL program continued their Air Force careers, some reaching high ranking positions in the Air Force space program or other branches of the service. Others moved into industry or to NASA, including seven of the MOL astronauts in the fall of 1969. Not having to undergo basic academic and survival training allowed them to progress almost immediately to support roles in NASA's programs.

Thirteen years later, the STS-4 mission in 1982 that included former MOL pilot and 1969 transferee, Hank Hartsfield, completed the final test flight of the Shuttle *Columbia*, on a partly classified DoD mission. The story came full circle on STS-51J in 1985, when former MOL and Group 7 transfer astronaut Karol Bobko commanded the maiden launch of *Atlantis*, which saw the deployment of a pair of DSCS communications satellites. The type of satellite and upper stage which had led to the demise of MOL and defined the design of the Shuttle payload bay became primary military payloads on a flight in which a former MOL astronaut was part of the crew, performing very different – but still classified – duties to those they had arduously trained for under MOL.

MOL FLIGHT CREW TRAINING PROGRAM

As MOL had been developed with a human presence integral to the system, an effective training program had to be created to prepare its crew members for both the ride to orbit and back on Gemini and the 28 or so days of orbital activities planned for them within MOL. The training also had to cover, as much as possible, any contingency or unforeseen circumstances they might encounter during their missions. While it would have been less complicated to operate a fully automated system than to provide for a human crew for up to a month, the inclusion of astronauts in MOL was intended to provide much-needed experience for developing any future military man-in space programs.

The stated benefits of including human crews in the MOL system were:

- Manual backup for complex automated functions, especially in the development phase.
- Manual repair or adjustment of sensor elements, controls and displays during on-orbit operations.
- A greater percentage of cloud-free photography.
- A possible quick reason intelligence read-out capability.
- Target selectivity.

To achieve this, it was recognized that the MOL astronauts would have to become fully familiar with the laboratory and associated camera equipment and would have to be trained on telegenic target recognition and aspects of photographic intelligence interpretation. Added to this, and due to the nature of the broader mission objectives, the astronauts would also have to be skilled in handling "certain intelligence products," which would allow them to cue targets real-time during the mission; systems which, in the mid-1960s, required high security clearance to operate. If this experience was not afforded them in training, it would "seriously limit the use of man as an integral part of the MOL intelligence collection system." [12] Added to the hardware and payload training were the essentials required to enjoy at least a comfortable existence in orbit, including personal hygiene skills, eating and drinking, physical exercise, housekeeping, maintenance and sleep. Unlike their NASA colleagues, however, the MOL astronauts would not have to concern themselves with dealing with the media and the public.

In fact, the degree of public openness posed something of a conundrum for program officials right from selection, given the dilemma of publicly identifying the men as MOL astronauts, while at the same time restricting information on what they were training to do on their missions. Officials were concerned that identifying the men could potentially make them "targets for individuals, groups or foreign intelligence organizations intending to acquire classified information." This was most likely to occur because of system malfunctions and an emergency return in hostile territory, the failure of the launch vehicle to place the MOL and its crew in orbit, or following an emergency recovery and landing incident. To mitigate such risks, a series of policy directives were instigated to avoid situations in which MOL astronauts and the information they held could be found with "incriminating intelligence mission products" [film], which might be construed as hostile and threaten their safety.

The MOL Program Plan, dated June 15, 1967 [13], included an overview of MOL crew training:

The objective of the MOL Flight Crew Training Program is to provide flight certified space crews trained to accomplish the MOL mission. The objectives and the established Flight Crew Training Concept and Implementation Plan are included as part of a formal Flight Crew Training and Activities Plan. Flight Crew training consists of the four basic phases described as follows:

1. *Phase I – Indoctrination. An Indoctrination Phase is conducted at the MOL Systems [Program] Office (SPO) as an introduction to the MOL Program and as a prerequisite to the Aerospace Research Pilot Course. Phase duration is two months. During this indoctrination, the crew member is given general knowledge on all aspects of MOL. This is accomplished through briefings at the MOL SPO and field trips to NASA and contractor facilities. Tentative duty assignments for the Engineering Development – Crew Integration Phase are made during this period.*
2. *Phase II – MOL ARPS (Aerospace Research Pilot School). The MOL ARPS course is conducted at Edwards AFB, California, and consists of classroom, flying, and simulator training. Phase duration is five months. The objective of the course is to provide the crew member with technical courses related to MOL vehicle systems, operations procedures, and mission plans. Classroom instruction is provided in subjects as technical background to the MOL or as special courses uniquely MOL oriented. Subject material consists of higher mathematics, astronomy, structures, guidance and control, etc., plus*

MOL mission peculiar courses. Instructors are provided by ARPS, contractors, civilian agencies, and Aerospace Corporation. The simulator training is accomplished on the T-27 space flight simulator using MOL ascent, orbital, and re-entry parameters.

3. *Phase III – Engineering Development and Crew Integration. The Engineering Development and Crew Integration Phase involves active participation of the crew member in the design and development of hardware and the determination of operations procedures. This is a continuous training effort throughout the remaining period of time before assignment to a flight. Each crew member is assigned an area of responsibility which he operationally and technically monitors and to which he provides crew inputs. Government agency, contractor, and other supported training are also accomplished during this period. Contractor courses are provided on an as-required basis. MOL Systems [Program] Office training includes background, environmental, and contingency training.*
4. *Phase IV – Pre-Flight Training. Upon assignment to a specific orbital flight, the primary and backup crews will commence 12 months' training as prescribed by the formal Preflight Training Plan. The majority of Preflight Training will be conducted in the simulator at Vandenberg AFB, California. The total MOL Mission Simulator is composed of three sub-simulators; the Gemini B Procedures Simulator (GBPS), the Laboratory Module Simulation Equipment (LMSE), and the Mission Payload Simulation Equipment (MPSE). Each of these sub-simulators can be operated independently and concurrently or in integration with the others. Training consists of systems, part and whole mission simulations, and courses on systems, all aspects of operations, and mission plans.*

In addition to the four training phases, proficiency flying and physical training are conducted throughout the life of the program. General Contractor training support is covered in separate contracts with associate contractors. Each Associate provides inputs to the Flight Crew Activities Plan on a semi-annual basis until the publication of the Flight Crew Training Plan by the Systems [Program] Office. Training requirement updates are required from the contractors prior to each manned launch. All training equipment used shall be supplied, modified, or refurbished by the contractors. This includes the government furnished equipment from NASA. There are eight major training hardware items.

These are:

1. *Laboratory Module Simulation Equipment. The Laboratory Module Simulation Equipment (LMSE) provides functional simulation of all subsystems characteristics that affect the operation of the Laboratory Module and the Crew Interface.*
2. *Mission Payload Simulation Equipment. The Mission Payload Simulation Equipment (MPSE) function is identical to the Lab Module Simulation Equipment.*
3. *Gemini B Procedures Simulator. The Gemini B Procedures Simulator (GBPS) will be used to train the Flight Crew and Ground Controllers in the Launch, Ascent, and Early Orbit, and Re-entry portions of the Manned Orbiting Laboratory (MOL) flight profile. (These three simulators, operating simultaneously with the Mission Control Center and Satellite Control Facility, provide total mission simulation).*
4. *Zero "G" Trainer. Zero "G" trainer simulation may use a series of simulators, including the C-135 Flight using Keplarian trajectories, underwater and air-bearing platforms.*
5. *Abort Trainer. The Abort Trainer provides a concentrated detection and crew action activity limited to abort.*

6. *Flotation-Egress Trainer. A mock-up of the Gemini B provides experience for the crew in post-landing flotation and emergency escape in the event the spacecraft begins to leak.*
7. *Centrifuge Trainer. Provides experience for crew activities during powered flight.*
8. *Development Simulator No. 2. This is an early mission payload simulator that permits early examination of design and operation of the mission segment.*

The general training support funding includes special courses, planetarium training and reimbursable training at government facilities for water egress, launch abort, centrifuge, parachute and zero-g training.

Putting theory into practice

In the weeks prior to each manned launch, a complete mission dress rehearsal would have given the flight crew and mission control personnel an opportunity to refine the skills required during the actual flight. At the end of several years of formal training, the crew would have completed nominal, emergency and backup operations using the MOL Mission Simulator (MS), simulating all stages of their planned mission. At Vandenberg AFB Launch Complex 6 in California, the crew would have simulated the launch and ascent phase of the mission using the relevant base facilities and crew escape systems, and replicated mock launch pad and launch ascent aborts in various modes and associated emergency recovery scenarios. For the orbital simulations, the rehearsals required the MS to be linked to MOL MCC for at least 16 revolutions (or 24 hours).

The two-man flight crews were intended to be launched and recovered in the adapted NASA two-man Gemini spacecraft, designated Gemini B. In order to fulfill this requirement, a Gemini B Procedures Simulator (GBPS) was provided for crew training. This simulator provided the crew with control and monitoring operations during the launch phase, ascent to orbit, early orbital operations at the start of the mission, and late orbit operations (including the 'loiter' phase) towards the close of the mission and for re-entry. Ascent simulations included the crew monitoring and detecting malfunctions that could lead to an abort situation. Upon reaching orbit, the crew would have ensured that a safe and correct orbit had been attained and, if necessary, commanded engine firings on the laboratory module to trim the orbit to the required parameters.

For the early orbits, the two astronauts, who would have trained in various abort modes in the event of an imminent failure and early return, were also instructed in diagnosing and controlling various failures in the Gemini B spacecraft. After entering the planned orbit during a nominal mission, the two astronauts would have placed most of the Gemini systems into hibernation mode prior to transferring to the laboratory module. This would ensure that data between MCC and Gemini B was maintained, to monitor systems during the period the crew was in the MOL. To simulate work within the MOL module, a Laboratory Vehicle Procedures Simulator (LVPS) was constructed, to provide familiarization with the hardware, systems and facilities inside the laboratory, and for setting up and closing down the lab at either end of their mission. For the close of the mission, the GBPS provided the platform to practice the 'loiter phase,' in which the Gemini B would be powered up again before separating from the laboratory and completing re-entry and landing. The total solo flight time for a Gemini B, detached from the MOL, was stated to be no more than 14 hours.

Keeping within official policy

One of the interesting aspects of the declassification of documents, half a century after the program was operating, came from the guidelines with which the MOL astronauts were selected, trained and advised of their role in the program. [14] The guidelines were designed to reduce the risks of compromising security or embarrassing the U.S. Government "to an acceptable minimum without impairing mission objectives."

From the time they were attached to the MOL office, all astronauts retained their rank in their respective parent military services. However, while the selectees of each group were publicly identified, the extent of their exposure to the public was controlled in keeping with the strict security of the program. The MOL astronauts were "required at all times to maintain a high standard of moral, ethical and military conduct." The silence that endured for over 40 years after the termination of the MOL program is testament to the policy the men signed up to, their devotion to duty and their commitment to the program to ensure that this was the case, until officially informed they were able to do otherwise.

A not so open program

While the "identities and general background" of the MOL astronauts were released publicly, they were not allowed to be interviewed by the press, appear at public events, or write about their experiences. In cases where the training program required visits to locations connected to the program's intelligence missions, details of their presence at the relevant facility to unauthorized personnel, the media or general public were under embargo. Wherever possible, such visits were avoided to prevent any breach of security. Locations which were highly sensitive to visits by MOL astronauts included the NPIC and the contractors tasked with developing MOL's camera systems and other classified mission-related hardware.

In undertaking such visits, the astronauts traveled and toured in their civilian clothing, often with false identification to hide their identity. According to Don Peterson, [6] this became increasingly difficult for Robert Lawrence, who had been chosen with the third MOL group and was the first black person selected for American astronaut training. Lawrence's inclusion in the program also worried the officials, as the press came to know him by sight, but to his credit Lawrence tried hard to shun their attention, which would have been counterproductive to the program and could have led to unwanted publicity for the other astronauts and what they were all doing.

What happens if?

One underlying concern for MOL program managers was the very real problem of handling an off-nominal recovery of a crew from space, having landed in potentially unfriendly territory. The post-flight recovery of any space crew is always a difficult and hazardous phase of any mission, and must be treated with due care and attention. A slip or oversight late in the mission could be as unforgiving as an error right at the start, or as the flight unfolded. For the MOL astronauts, there was the added problem of being seen as part of a classified, military controlled mission, rather than the more open 'civilian' ones operated by NASA. In a memo from Alexander H. Flax to the Director, MOL, regarding the '*Policy Relating to MOL Astronauts*' on December 28, 1966, the problem of an emergency landing where the astronauts might descend into regions not considered friendly to the United States, or where their appearance might be considered threatening by some regimes was raised. This policy document stated:

> "MOL astronauts will be provided with no instructions, devices or equipment for purposes of bringing about their personal destruction in the event of an incident. Any equipment provided to astronauts, for purposes of survival, will undergo careful screening against a standard of practical application, to ensure that the purpose of such equipment can logically be defended as not intended to bring about the death or injury of another individual, or to induce such individuals to act in a manner contrary to their allegiance." [15]

MOL astronauts were intending to return to Earth in the Gemini spacecraft and a significant amount of the mission photography data would be stored on board with them. In case this return was in less friendly areas under emergency procedures, the return of the exposed film to U.S. officials might not be as straightforward as other items recovered from space under international agreements. The December 1966 memo continued: "In some emergency circumstances, the impact of the Gemini will occur in an area where U.S. forces cannot exercise prompt control. MOL astronauts, in the absence of other U.S. personnel, will attempt in a non-violent manner to exercise U.S. sovereignty over all MOL equipment, both while in space and on the Earth's surface. All MOL astronauts will be instructed that in the event of incarceration or interrogation by a foreign government, they will provide no information other than name, rank, serial number, date and place of birth, places of residence and the fact of their occupation as MOL astronauts. Under such conditions, the astronauts should request to be placed in contact with representatives of the U.S. Embassy or Legation, or in the absence of any U.S. representation, the International Red Cross. Astronauts will be advised that the U.S. government in such events will make every effort to secure their prompt release through regular diplomatic channels."

Planning for flight testing and operations

On May 8, 1968, a little over a year before the total cancellation of the program, the MOL Systems Program Office issued the initial 290-page MOL Flight Test and Operations Plan. [16] In his foreword, Major General Joseph S. Bleymaier, Deputy Director of MOL, stated, "although this initial issue of the [report] may contain errors and differences, it was being released to allow top level guidance to all contractors and government agencies who were to be involved in tests and operations of MOL." As new information became available, it was planned that updates to the document would be issued through the Flight Operations Planning Group. Section 8 of the document related to crew operations by the MOL astronauts, but even this included the proviso that "much of the details for this Section have yet to be developed. Currently, studies are in progress to more clearly define the details of crew operations and the evaluation of man's contribution."

Almost 50 years after the publication of this report, which was issued some five years into the program with the MOL astronaut group down to 14 members, it seems incredible that even the basic crew activities had still not been resolved much beyond the objectives listed when the first astronauts were assigned to the program.

The primary role of the crew onboard the MOL remained clear: "to enhance the operation of the photographic payload, to gather and relay intelligence data, to aid in the detailed development of the automatic system, and to perform as a backup in case of certain critical subsystem failures." As the systems and ground support developed to meet these requirements, it was hoped that, by alleviating the crew of any "unnecessary functions," they could use their time on orbit more effectively, thereby supplementing and enhancing the intelligence gathering information. In addition, with the crew monitoring applicable systems in the MOL Mission Module (MM), Laboratory Module (LM) and Gemini B, it was expected that the astronauts would be able to determine the root cause of most of the potential subsystem failures and effect repairs to correct the problem. As well as maintenance and housekeeping, the MOL two-man crew would select the correct operating modes for the onboard equipment, activate redundant units, replace or repair failed components, and "perform equipment functions until other corrective actions can be determined and taken." Clearly, each crew would be kept busy and active during their month on MOL.

There was also a 'backup' role for the crew, focusing on critical items requiring manual target acquisition, centering and tracking. Had the Attitude Control and Stabilization System (ACTS) subsystem failed, the astronauts would have aligned the main optics equipment, controlled the attitude of the spacecraft and managed the use of propellant to maintain their attitude. They would also have been called upon to use manual control for onboard atmosphere and temperature regulation, and if the telemetry downlink had failed, the crew would report over the voice link on the status of various systems. The onboard optical systems intended for MOL were still under development, so the crew would need to be able both to diagnose and evaluate any errors in the pointing and tracking of the main optics, using a series of reviews and tests as the hardware was prepared.

The nature of the images taken by MOL required the crew to evaluate what they had captured on film promptly. To do this, the onboard processing systems allowed captured images to be developed so that the crew could examine them. The presence of the astronauts on MOL took full advantage "of the crew's ability to enhance the quality of the intelligence gathered." To ensure this was effective, the system had to allow the astronauts to assess the local weather patterns rapidly for pre-programmed photographic targets, with systems in place to allow for either one- or two-man operations in the primary (manual) or backup (automated) modes. The crew could visually reconnoiter the target while commenting on the real-time state of the area, employing a range of tools such as the Acquisition and Tracking Scope (ATS), visual optics or processed images, to support mission planning and targeting decisions and help preclude an abort in the event of a systems failure. In safety-related cases, the crew could also override or modify ground-generated commands. Unfortunately, this procedure remained time consuming and involved for all concerned and was cited as one of the program's downfalls when compared to the rapidly improving automated satellite imagery capture and downlink systems being developed at the same time as MOL.

The role of man in the MOL system

The above planning document was issued in conjunction with several others, detailing the effectiveness of man in the MOL systems. Most notable of the releases was an October 1967 paper on the contribution of the crew in the MOL/DORIAN systems. [17] This document was derived from a briefing by Harry Bernstein of the Aerospace Corporation to a panel headed by Dr. Edwin Land of the President's Science Advisory Committee (PSAC) on August 29, 1967. The primary objective of the early missions was "in bringing the total system, particularly those elements of the systems associated with the unmanned or automated configuration, to a mature level at the earliest possible time." Previous experience from unmanned programs had shown that it would take "a considerable number of flights" to fully mature the operating systems. The complexity of the DORIAN system, in comparison to those earlier programs, "suggests that the flight crew can provide valuable services in terms of bringing the systems to a mature status and at the same time still obtain a significant level of high-resolution photography reconnaissance data." Unfortunately for MOL, there were certainly far less than "a considerable number of flights" planned in the program.

It is not the aim of this book to detail the history or operations of MOL, but for the purpose of this narrative, the functions of the MOL astronaut on orbit would have been:

- To ensure the MOL vehicle remained in orbit for the maximum duration planned, thus allowing as much data as possible to be gathered; to maintain and operate the spacecraft and onboard systems in a possible degraded state, including maintenance and equipment change out.
- To perform regular health checks on the various onboard systems, notably in the mission payload area and the laboratory itself.
- To diagnose certain failures or off-nominal situations, both to verify the telemetry and supplement the information received on the ground. The fact that MOL was, for the most part, a manned vehicle meant this analysis would have been more rapid than if the laboratory had been fully automated.

Crew Activities

In the release of NRO MOL documents in 2015, there was very little related to the activities and experiences of the astronauts chosen to fly the missions, which therefore remained classified. However, in the Preface to *The DORIAN Files Revealed: A Compendium of the NRO's Manned Orbiting Laboratory Documents,* James Outzen wrote that the CSNR[3] anticipates, "releasing a new history of the MOL crew members in 2016. A CSNR oral historian is preparing the history, based on interviews of MOL crew members and other documentary research. We believe that this history, in conjunction with the oral history, will provide more insight into the MOL program, especially with respect to the human involvement in the program." [18] By the close of 2016, these documents were still to appear and remain eagerly anticipated.

In his 2001 NASA Oral History, Hank Hartsfield revealed that the early crew training for MOL was focused upon operations, but did not reveal any details. He went on to explain that their training was developmental in concept: "We were participating in the development schemes for running the experiments." [19] Despite the lack of detail over the years, information about certain aspects of crew activities has been released. In the 1967 document, *Contributions of man in the MOL/DORIAN System*, reference was given

[3] The Center for the Study of National Reconnaissance (CSNR) is an independent National Reconnaissance Office (NRO) research body reporting to the Director, Business Plans and Operations.

to the simulations carried out at SAFSL/Aerospace facilities, which were intended to determine the level of flight crew performance during detection of active targets. The simulator located at the Aerospace Corporation was a static design, which precluded motions of targets, and was never intended to be an exact duplicate of the orbital vehicle. During early tests on the simulator, seven (unidentified) MOL astronauts participated as subjects to gain an insight into operating the system on the actual laboratory. There was a limit to pre-test training that could be undertaken by the astronauts involved, who were mainly hindered by time to evaluate the results of the training session. At the time, after each training session where a ground-target had been examined, the astronaut concerned would produce a statement outlining the decisions he had made during the exercise. Following the test, the astronaut would then discuss with the test conductor the reasoning behind these decisions, with priority given to where the response from the astronauts did not reconcile with earlier testing results.

Further training involved the astronauts flying simulations in aircraft, which complemented ground simulations while affording a variety of viewing conditions. One issue which became a problem for MOL training was that all the targets were external to the United States and of a sensitive nature, and therefore impossible to simulate accurately, with heavy reliance on technical intelligence and the use of aerial photography. The challenges facing the astronauts and trainers included the fact that the available material was only in black and white, not color; it was two instead of three dimensional; and that dynamic aspects such as variations in the atmospheric haze, line of sight, sun angles and the motion of the target could not be replicated.

While the MOL/DORIAN system was designed primarily for Earth-based reconnaissance missions, it was capable of visual spectrum photography without any modifications and could therefore support an astronomical program of planetary photography. Simulations of this technique, once again using members from the flight crew pool, revealed that the MOL laboratory could be rolled to the appropriate attitude to direct the lab's main camera systems to fix onto the target planet. Extensive studies of the mission timelines also determined that these secondary astronomical 'scientific' observations could be accomplished without interfering with the primary 'military' mission.

The Simulated Laboratory Module (SLM) was the focal point for familiarizing the MOL crew with the internal arrangement of the laboratory that would also be their home for a month. Designed as a high fidelity dynamic simulator, the view through the various optical instruments reproduced an authentic field of view for familiarization training. Interestingly, the upper compartment crew quarters (similar to the wardroom area on the later Skylab workshop) were only functional mockups of the actual vehicle, due to the one-g conditions the astronauts had to train under. The SLM included ladders to allow access to the controls and devices located in the upper area of the simulator.

The crews were also provided with several part-task simulators. As well as a training tool, these trainers were used for gathering early engineering and operations data. They included:

- *Engineering Development Simulator (EDS):* featuring a single crew station with simulated visual displays, and hand controllers for acquisition and tracking, as well as for magnification and target cue projection.

- *Mission Development Simulator (MDS):* a second crew station, with associated equipment bays located on the flight vehicles. The objectives of this equipment were to develop and help verify the AVE software, to develop mission procedures, to serve as a crew trainer and to obtain statistical data on crew performance as a baseline for subsequent mission operations.
- *Abort Simulator:* The abort simulator was derived from NASA's Gemini crew compartment gondola, converted to Gemini B configuration, and was used to simulate events from pre-launch through to launch, early ascent and the climb to orbit insertion. Its various programs were used to test the crew's ability to respond and react to simulated high stress situations, such as how the crew evaluated displays and controls under duress and how they reacted to the various failure modes. It was also used to complete simulations of both nominal and contingency operations, and to provide a refresher course prior to each mission.
- *Zero g simulator:* To familiarize the astronauts with the environment they were to live and work in, the USAF utilized both aircraft flying parabolic trajectories and the relatively new training aid of underwater neutral buoyancy facilities. From August 1964 to May 1968, a series of 12 ballistic trajectory flights was completed using a modified KC-135 aircraft out of Wright-Patterson AFB, Ohio. This flight program included crew orientation, evaluation of proposed MOL pressure garments, and development tests. The development tests included simulating the transfer of crew members from the Gemini spacecraft through the rear hatch and tunnel into the MOL laboratory, suit donning and doffing, use of the waste management systems and the crew's personal hygiene equipment, and evaluations of various restraints in the laboratory module. Further parabolic flights were planned to continue such developments.

At the start of the MOL astronaut training program in early 1966, the concept of water immersion for neutral buoyancy simulation of EVA tasks was still new. It was not adopted into NASA's Gemini program for astronaut EVA training until later that year. By the end of 1966, the USAF was benefiting from studying and learning from the series of Gemini EVA excursions and training processes in planning its own EVA operations from MOL. At the time of the MOL report (May 1968), very limited underwater tests had been completed, but they included evaluations of crew restraints, and defined the limits of reach and the astronaut's operating envelope while wearing a pressure suit, as well as practicing EVA crew procedures. Additional tests were planned, to evaluate the locations for external crew work stations and to develop detailed timelines for durations far beyond the few seconds per parabola available on the KC-135.

In his 2007 NASA Oral History, Al Crews recalled an underwater training facility being built and operated by General Electric, the MOL payload contractor. "We had an underwater facility down off the Virgin Islands, and we had a cockpit there and then the capability of operating in pressure suits. We did that as they were building an underwater facility up at General Electric, but then we never did use it. About the time it got ready to be operational was when they cancelled the program." [20]

- *In-house simulations:* This series of simulations was used as rapid, but limited evaluations for operational procedures and concepts of flight hardware. They provided a useful baseline upon which to develop future and more extensive simulations using the larger simulators.

- *Human centrifuge:* As with the Abort Simulator, a former element of NASA's Gemini training program was transferred to and utilized by the MOL astronauts in their own training program. The centrifuge gondola was updated to include Gemini B controls, displays and crew restraints and was fitted into the human centrifuge at the Naval Air Development Center (NADC), Jacksonville, Pennsylvania, where it was to be used to simulate nominal and emergency acceleration and deceleration profiles for ascent and entry. Pairs of MOL astronauts were to complete runs in the centrifuge, during which they could evaluate the controls and displays and the restraints under realistic acceleration and deceleration conditions. However, it appears that the MOL group never completed this phase of training.
- *Gemini B egress trainer:* The original Gemini egress trainer had also been used by NASA astronauts and was transferred to the MOL program once NASA no longer needed it. It was modified to replicate the Gemini B configuration, its interior, recovery equipment and escape paths. Water egress training was necessary for nominal recovery and for crew survival in the event of an emergency water landing, but getting out of the cramped crew compartment, with its added canisters of returned film, proved challenging even under nominal conditions in calm water.
- *Subsystems test article and mock ups:* During their training, the MOL astronauts attended several lectures delving into the systems and subsystems of the MOL and Gemini B spacecraft. Following bench tests of specific items of equipment, they participated in various subsystem tests, and simulations. The integrated systems tests they took part in were held at the Electronic Development Component Test Unit (EDCTU) at the Douglas Aircraft Huntington Beach Facility in California. By participating in these tests and simulations, each astronaut gained a greater understanding of the particular system or subsystem and its interaction in the larger vehicle.

Developing a plan for flight and a crew to fly the mission

The MOL training program for both flight and ground personnel was designed around a mission profile of pre-flight activities, powered flight (launch), orbital operations, separation and entry, recovery, and post-recovery operations. Training for each member of the MOL astronaut team included direct participation in engineering, development and various testing programs. Mission training was envisaged to be completed in three phases, while concurrently having each crewmember maintain both their flight proficiency in high performance aircraft and their personal fitness, and observing a high level of security at all times.

Preliminary training: This began shortly after selection. As mentioned earlier, if they had not already completed ARPS, this would be required prior to commencing their six-month basic training program. This included academic lectures, a series of field trips, system briefings, simulations and an extensive flying syllabus.

General Training: Upon completion of ARPS, each astronaut was reassigned back to MOL SPO in Los Angeles, California. Here, they received classified briefings on the DORIAN system and other mission-orientated hardware and systems. Each astronaut

Al Crews wearing the MOL pressure suit. (Courtesy USAF)

would then receive a technical assignment in engineering or operations. These technical assignments could have included serving as crew representative for a particular system or item of hardware, perhaps as a point of contact on any developments or crew safety issues. Not all the details of the various technical assignments are known, but those which have been identified were: [21]

- Abrahamson – simulators; classified payloads (technical procedures and flight manuals)
- Crippen - computers
- Fullerton – boosters (displays and controls)
- Hartsfield - Gemini B/communications (MOL flight control system)
- Herres – possibly classified payloads (managerial assignments)
- Lawyer – Pressure suits and EVA
- Macleay – classified payloads
- Overmyer – pressure suits and EVA
- Truly – classified payloads (computers)

The general training program also included emergency or contingency wilderness training. These courses included water, tropical (jungle) and desert training. Additionally, since MOL would be operating in a polar orbit inclination where an emergency landing could occur over most areas of the world, mountain and arctic survival training was added to the program, something the Soviet/Russian cosmonauts practiced in their general and mission training, but which NASA's programs did not require. While there remains little detail available, the MOL astronauts probably followed a similar program of training to that of NASA's astronauts (see Chapter 4). Unlike their NASA counterparts, training in rendezvous and docking operations was not part of the MOL training program, as the crews would use the Gemini B mainly for ascent and recovery.

Gordon Fullerton evaluating a pressurized MOL suit. (Courtesy USAF)

In preparation for possible EVA training and simulations of microgravity, the MOL astronauts were trained in scuba-diving and EVA techniques. After leaving NASA in 1986, former MOL astronaut Bob Overmyer wrote a number of articles about his spaceflight experiences for the UK monthly magazine *Space Flight News*. In May 1988, one of these articles concerned the scuba-diving training he and his colleagues had received during their time with MOL. [22] In the article, Overmyer explained that each MOL group had undertaken a civilian Los Angeles County scuba-diving course, which included trips to Catalina Island some 26 miles off the LA shoreline. To supplement this, the astronauts completed a military course at the U.S. Navy Underwater Diving School, Key West, Florida. During the MOL years the astronauts trained in the Virgin Islands, simulating the transfer from the Gemini spacecraft through the internal tunnel into the laboratory.

Specific Flight Training: There were five manned flights planned under the MOL program, though none ever flew. Had the program progressed as planned, a six-person training group, comprising two-man prime, backup and support crews, would have been assigned to each mission approximately one year prior to flight. As with the Apollo program, which also relied on a three-team structure for each mission, the prime and backup crews would have begun specific mission training for the flight to which they had been assigned. The support crew would have assisted the prime and backup crews by participating in the myriad of prelaunch activities that require astronaut participation during checkout, system integration, planning of flight operations, simulations and countless rehearsals.

Each crew would have coordinated some of their training with teams in the support rooms and mission control, as well as at the launch and recovery sites. The announcement of a MOL mission would have probably been made after the launch had occurred, as with the Soviet military Almaz missions (using Salyut-type stations) in the early 1970s, or like the military Shuttle missions. There would probably have been a brief announcement of a successful launch, and perhaps another after a safe recovery. Launch and landing times would not be made public in advance, and details of the mission would certainly not be released, although brief statements might be released as the mission unfolded. If an EVA had occurred, it remains unclear whether this would have been reported.

At one point, the MOL program considered using the Fulton Surface-To-Air Retrieval System (STARS) to pick up personnel by aircraft in some recovery zones after they landed. Developed for the CIA in the early 1950s by Robert E. Fulton Jr., the USAF and USN used this system to retrieve personnel on the ground using a skyhook system, which featured a personal harness attached to a 500 ft. (150 m) braided nylon line, raised by a dirigible-shaped balloon inflated by a portable helium bottle. The line would catch in steel forks located on the nose of the recovery aircraft, at which point the balloon was released and the line attached to a powered winch to pull the downed airman on board. The equipment featured as a unique part of the MOL training program, although no live pickups were ever attempted.

Despite all this preparation, by the beginning of 1969, the prospect of there being any manned flight in the program *at all* looked bleak. The astronauts were getting used to perpetual three-years-to-launch parties because the first flight continually kept slipping, until June of that year when it was finally all over.

THE DEMISE OF MOL

The MOL program was probably fighting a losing battle throughout its existence. Its costs continued to spiral and there was the perceived duplication of its purpose with that of NASA's Orbital Workshop (OWS) within the AAP; so much so that on March 21, 1966, a House Government Operations Committee report into the two programs suggested that cooperation between them would yield significant cost savings for both budgets. [23] Other factors included the growing costs of the Vietnam War and its drain on the USAF budget, forcing cutbacks to any program not directly involved with the conflict in South East Asia. By the late 1960s, there had also been significant developments in unmanned reconnaissance satellite technology, putting into question the value of adding a human crew to a spacecraft, which would complicate its systems and perhaps yield little significant return for doing so. Finally, at a time of unrest and disdain for the shortcomings of national and international social programs, there was little appetite for using public revenue on extensive DoD and space exploration programs. At the time of the cancellation, the official DoD reports noted that the MOL program, had been "well managed," and that "those involved had achieved significant results."

The only 'flight' of MOL hardware occurred on November 3, 1966, when a mockup of the laboratory and the unmanned modified Gemini 2 spacecraft lifted off atop a Titan 3 rocket on a 33-minute suborbital flight from Cape Kennedy. The Gemini 2 capsule had been refurbished following a successful NASA suborbital test flight ten months earlier. It remains the only Gemini spacecraft to have lifted off bearing U.S. Air Force insignia.

What the astronauts thought

According to James Abrahamson, the MOL team tried to learn from NASA about balancing technical problems with a lack of funding and slippages, but they failed to learn enough, which resulted in the termination of the program. In a major program review, just after Abrahamson's selection in 1967, managers and astronauts were asked if it would be better to slip the planned launch dates or trim the program down, due to technical problems and its obvious underfunding. The team believed they would be successful once they began flying and thus preferred the slippage option, but further reductions in the annual budget did not help. The same thing occurred in 1968, and again in 1969, but this time newly-elected President Richard M. Nixon decided to cut his losses and cancelled the program. According to Abrahamson, MOL "was cancelled not because we slipped, but because of the political situation and the technical situation. All kinds of things changed during that timeframe. It didn't appear that we were going to be the big change in technology that we had thought we would be and could be. So the lesson is do not slip, no matter what, even if you're just going to put an empty tin can up there, and always take whatever progress you can get to build on that instead of slipping." [**24**]

Bob Crippen recalled the cancellation of MOL "as one of the lows in my life." The idea of asking to transfer to NASA was not widely thought of as an option, as the civilian space agency already had more than enough astronauts at the time. But even though Director of Flight Crew Operations Deke Slayton was clear that he needed no additional astronauts, the Associate Administrator of the Office of Space Flight, George E. Mueller, instructed him to take some. The arbitrary cut-off age was set at 36 and Slayton informed the seven selected MOL pilots that while he had lots of work for them, there would be no flight seats until the Shuttle flew – and that was probably not going to be until the late 1970s. At this point, the Shuttle program had not even been approved but, as Crippen remarked, "It sounded good to all of us, and all of us came (to NASA)." [**25**] As it turned out, they would all have to wait until between April 1981 and April 1983 to fly their first mission.

On what the MOL astronauts came to call 'Black Tuesday,' Gordon Fullerton was conducting proficiency flying out of Los Angeles International airport, shooting approaches at Palmdale, when he heard on his radio an order to return and land. After landing, he was told the program had been cancelled. It was "a real blow, although not a big surprise," he recalled in 2002. [**26**]

Don Peterson says the MOL program died for lack of funding. "General [Joseph S.] Bleymaier was the commander, and he finally went to [President] Nixon and said, 'Either fund this program or kill it, because we're burning time and money and we're not making progress because we don't have enough funds,' and Nixon decided to kill it. I don't know whether that was a good or bad decision … I thought what Bleymaier did was the right thing to do, because the program was floundering, and we were spending quite a bit [by Air Force standards], but not much money by comparison with the NASA programs, by the way … I think the biggest amount of money that program ever spent in one year was $300 million, and that's pretty small by comparison, say, with a Saturn or the lunar program or the Shuttle." [6]

"During that period, we'd made many trips to NASA [centers]… so I got to know all the NASA [astronauts]," said Dick Truly. "I already knew many of them, but during that period I got to know just about all of the NASA astronauts during the sixties. We would go to launches. But we were in a different program, which was a military program."

Hank Hartsfield was on the way to an early morning meeting at Douglas Aircraft in Huntington Beach when he heard the news of the cancellation on the car radio. When he got to Douglas, "it was like walking into a morgue." With MOL cancelled, Hartsfield thought he would be going to Vietnam, but was told he could not do so because of a two-year duty and travel restriction – a result of the classified nature of the MOL program – which meant they could not be front-line pilots. None of them wanted to 'fly a desk,' so everyone looked at different options. But underlining each decision was the fact that being out of the Air Force system for several years also meant they had missed the normal promotion path.

Visiting NASA after the cancellation of MOL, Hartsfield recalled that Gen. Tom Stafford, who had recently flown on the Apollo 10 lunar mission, accompanied the MOL astronauts on a tour of the facilities at Houston. He told them that Project Apollo would likely end around Apollo 20, but there was the OWS (soon to be renamed Skylab), maybe a second Workshop and perhaps even a third, so it was possible they would get the opportunity to fly soon. But nothing seemed to come of it, so Hartsfield decided to return to study for his master's degree at the University of Tennessee Space Institute in Tullahoma, Tennessee. He was all packed and the family ready to drive from LA to Tennessee when he received a call from Bob Overmyer, telling him that seven of them had been accepted by NASA. Hartsfield called Stafford to discuss this and was told to continue with his degree, as it would be quite some time before any of them flew. While Hartsfield was studying for his degree, he also made several visits to Houston and Florida during breaks in the school curriculum, to begin the indoctrination process to NASA.

Like the rest of his MOL colleagues, Hartsfield was disappointed by the cancellation of MOL, "because at the time it was cancelled, we could touch the hardware. They had the flight hardware built and tested. In fact, one of the modules which Douglas built had already been shipped to GE [General Electric], where they were going to install the guts of the lab. So that was coming along very well. The pad was 90 percent complete [and] a lot of the construction at Vandenberg had been completed. The building was being outfitted and we were becoming convinced that the program was real; it was finally getting off the ground. We would be able to do something, even though it was still a couple of years away." [19]

TRANSITION TO NASA

As with his earlier assignment to the MOL program, working as a civilian astronaut with NASA suited Don Peterson. “Well, I was happy … I joined the MOL program because I wanted to fly and do those kinds of things, and I figured that the assignment at NASA would be very similar, and it was, except none of it was classified. I shouldn’t say that. There are a couple of little items that NASA usually said are classified. But by and large, the NASA program is wide open, and not only is it open, they advertise things.” [6]

Karol Bobko recalled that, in June 1969, “I was stationed in Los Angeles at [the] Space and Missile Systems Organization and spent a couple of years there in the MOL Program, participating in the development of that activity … I think we all thought that it was going to come to fruition. It was a surprise that it was just cancelled one day. I can remember I had a classmate from the Air Academy that had come to the MOL Program and it was his first day, and they called everybody down to the auditorium, and they said, ‘Guess what, folks? The program’s been cancelled’.” [27]

With the cancellation of the MOL program, Bobko joined his colleagues Hank Hartsfield and Don Peterson in deciding to go back to school and also complete his military service. Bobko was going to study for his master’s degree in Aerospace Engineering at the University of Southern California (USC). He was later informed he was one of the seven MOL astronauts who were being transferred across to NASA’s civilian space program and all had to volunteer, but without any of the fanfare of the earlier selections. As with his two colleagues, Bobko was advised to take another six months to complete his studies, and then join NASA for their training program after graduation. Bobko graduated with his master’s degree in 1970.

Don Peterson also returned to academic studies prior to joining NASA, working towards a PhD. With the Air Force Institute of Technology (AFIT) sponsoring his education at a civilian school, Peterson began attending the University of Tennessee in Knoxville, Tennessee, on a course of engineering science. Located at the Arnold Engineering Development Center, Arnold AFB, Tennessee, he studied a cross-range program involving thermodynamics, astrodynamics and math. He also had access to a wind tunnel program. Peterson surmised that he would have ended up being involved in some kind of aerodynamic research program after earning his PhD, but NASA changed their minds about when they wanted the new astronauts to report for duty, which made a mess of Peterson’s plans. Hartsfield and Bobko both earned their master’s degrees, but Peterson already had an MS and was hoping to get his PhD. He was told he could try instead for a second master’s, “but it won’t mean much,” which convinced him it was not worth pursuing. The problem was that the Air Force was not overly pleased about assigning officers to a school, only to see them not complete the program. As a PhD dropout, Peterson had to get special permission to leave the course. “We finally had to get the Undersecretary of the Air Force to waive that requirement so we could go to NASA,” he said in 2002. [6]

Dick Truly was another of the group looking at his options once MOL was cancelled. “Well it was a very exciting time in the space program,” he recalled. “All the NASA people were happy because they were getting ready to go to the Moon, and the MOL people were just crushed. I didn’t know what was going to happen to my career. I went to the Pentagon. The Navy was really good, though, and they offered to assign me to any airplane I wanted to fly in the Navy." For the two representatives of the U.S. Navy there were similar duty restrictions as with their Air Force colleagues once the MOL group had been disbanded. "We did have a restriction on travel," recalled Bob Crippen, with the Vietnam theatre out of the question in case they were shot down and captured. As former military MOL astronauts, their capture would have been a more effective propaganda coup than if they had been NASA astronauts. "But the Navy was very cooperative about other assignments [and] did offer to take care of us when we went back to the Pentagon," said Crippen [28]. "We had a 2- or 3-year restriction against going to Southeast Asia; Vietnam in particular," confirmed Dick Truly. "It caught [Jack] Finley out when he resigned from MOL. He did Med cruises until his restriction was over. On the other hand, when [Crippen] and I went back to Washington after the program was cancelled, the Navy offered us our choice of airplanes but the restriction was still in place and we would have to fly somewhere else (probably the Med) before we could have arrived at Yankee Station[4]. [29]

"[At the same time], there was a discussion between NASA and the Air Force about what to do with the MOL crew. At the time of the [MOL] cancellation, there were fourteen MOL flight [crewmen]. Deke Slayton and the people down at MSC didn't want us. They didn't want any more astronauts, because they already had too many … They were in the process of just starting Apollo. They were also in the process of winding down the program and looking at cancellations of Apollo 18 and Apollo 19. So, Deke didn't want us. Nevertheless, George Mueller … decided that they should take some of the MOL crew, and the agreement that was cut [with the Air Force] was that they would reassign the seven youngest MOL crewmen out of the 14 to NASA. Well, it turned out that of the original MOL crew that had been announced at that first press conference in 1965, I was the only one that was young enough [in 1969] to still be in the youngest seven of the MOL 14. So I never filled out an application [to NASA] … I'm the only person who has ever flown in space that never applied." [30]

So near and yet so far

The age restriction of 36 meant that seven of the MOL astronauts did not make the cut to join NASA. Jim Abrahamson thought that the civilian agency could draw upon the experience of the former MOL team of astronauts, program managers and other technical people, and indeed NASA Headquarters indicated they might all be needed to help with the emerging Shuttle program. However, the Astronaut Office indicated they had more than enough astronauts, given that the Shuttle was yet to be approved or funded. Eventually, discussions between NASA Headquarters, the Astronaut Office and the USAF MOL program led to the agency taking on the youngest seven MOL astronauts. Those aged 36 and over would not be transferred because of the expected ten-year wait for a

[4] 'Yankee Station' was a geographical reference point in the South China Sea, in the Gulf of Tonkin just off the coast of Vietnam. During the Vietnam War, it was used by USN aircraft carriers of Task Force 77 to launch air strikes. Its origin came from the 'Y' pronounced "Yankee" in the NATO phonetic alphabet and from the launch point ("Point Yankee") used by the aerial reconnaissance missions flown over Laos in 1964.

flight. This meant they would be in their late 40s before any likely chance of a flight into space. Abrahamson had turned 36 the previous May, and despite a personal plea to NASA Headquarters asking them to reconsider over a matter of a few months, he was turned down and returned to his Air Force career.

When MOL was cancelled, Al Crews was already too old to be selected by NASA. But he was so furious with the Air Force for not introducing any new aircraft for nine years and for letting the USAF space program die that he went looking for a non-astronaut position at NASA in Houston. Though he knew he was too old for the Group 7 transfer, he hoped this might change and that he would fit in, but did not realistically hold out much hope of making it into space.

For the seven members of the MOL class who were accepted by NASA, it was at least a step towards their goal of flying in space, even though they knew they would still have a long wait to fly, with most of the remaining flight seats on Apollo spacecraft already taken. The fact that it would be over a decade before the first of the seven would fly, some fifteen years after being chosen for MOL, was not what any of them expected.

References

1. ***USAF Test Pilot School, 50 years and beyond, 1944-1994***, 50th anniversary yearbook, USAF Test Pilot School publication, 1994, courtesy the Rex Hall Collection
2. ***X-Planes X-1 to X-45***, Jay Miller, Midland Publishing, 2001, chapter 2, Edwards AFB and Other Test Sites, pp. 16-19
3. Jake Ellison, SEATTLEPI.COM staff, January 5, 2016 article "*Declassified: U.S. had a secret military space program named DORIAN*," Online at: http://www.seattlepi.com/ local/science/article/Declassified-U-S-had-a-secret-military-space-6730497.php. Last accessed: November 22, 2016
4. MOL Monthly Status Report, March 1967, dated April 5, 1967
5. MOL Monthly Status Report, July 1967, dated August 7, 1967
6. Donald H. Peterson: interview by Jennifer Ross-Nazzal for NASA's Oral History Project, Houston, Texas, November 14, 2002
7. Handwritten notes on overview of MAN IN MOL, part of a slide presentation by Gen. James T. Stewart, September 1, 1967
8. Most details from an Email from Michael Cassutt, May 13, 2005
9. Memo dated July 5, 1968 from James T. Stewart, Maj. Gen. USAF Vice Director, MOL Program to Dr. Flax, NPIC
10. MOL Monthly Management Report, January 25 – February 25, 1968, dated March 21, 1968
11. ***The Hubble Space Telescope, From Concept to Success***, David J. Shayler with David M. Harland, Springer Praxis, 2016, pp. 101-102
12. MOL Directive No. 67-1, *Policy Relating to MOL Astronauts*, January 1967
13. *Section VII – Astronaut Training Part 1 – Flight Crew Training A. Phase Description* MOL Program Plan, Volume 1, dated June 15, 1967, courtesy NRO declassified documentation October 2015

14. Ref. 12; plus an accompanying memo from Alexander H. Flax, Director of the NRO, to the director of MOL, dated December 28, 1966
15. Memo from Alexander H. Flax for the Director, MOL, dated December 28, 1966, regarding '*Policy relating to MOL Astronauts*'
16. MOL Flight Test and Operations Plan, Manned Orbiting Laboratory Systems Program Office, Department of the Air Force, Los Angeles, California, May 8, 1968, Ref. L3517
17. Contributions of Man in the MOL/DORIAN System, Harry Bernstein, Associate Group Director, Operations Directorate, MOL, Aerospace Corporation, October 1967, WFS-127
18. ***The DORIAN Files Revealed: A Compendium of the NRO's Manned Orbiting Laboratory Documents Including Carl Berger's "A History of the Manned Orbiting Laboratory Program Office,"*** MOL Program Office Department of the Air Force, Washington, D.C., Edited by James D. Outzen, PhD, Chief, Historical Documentation and Research Center for the Study of National Reconnaissance, Chantilly, VA, August 2015
19. Hank Hartsfield: interview by Carol Butler for NASA's Oral History Project, Houston, Texas, June 12, 2001
20. Albert Crews Jr.: interview by Rebecca Wright for NASA's Oral History Project, Satellite Beach, Florida, August 6, 2007
21. ***Into the Black***, Rowland White, Bantam Press, 2016, p. 44
22. *Underwater Astronauts, The Overmyer Report*, Space Flight News, No.29, May 1988, pp. 12-17
23. U.S. Congress, House Committee on Government Operations, 1966, p. 46
24. James A. Abrahamson: interview by Jennifer Ross-Nazzal for NASA's Oral History Project, Herndon, Virginia, July 23, 2012
25. Robert Crippen: interview by Rebecca Wright for NASA's Oral History Project, Houston, Texas, May 26, 2006
26. C. Gordon Fullerton: interview by Rebecca Wright for NASA's Oral History Project, NASA Dryden Flight Research Center, May 6, 2002
27. Karol Bobko: interview by Summer Chick Bergen for NASA's Oral History Project, Houston, Texas, February 12, 2002
28. Email from Bob Crippen to David J. Shayler, January 24, 2017
29. E-mail from Richard Truly to David J. Shayler, January 24, 2017
30. Richard H. Truly: interview by Rebecca Wright for NASA's Oral History Project, Golden, Colorado, June 16, 2003

8

NASA's 'MOL(mag)nificent' seven

"Well, at least around me, we were all enthusiastic about the Air Force beginning to be interested in space with the Manned Orbiting Laboratory. If that had flown I'm sure we would have had a much more vigorous space program."
George Mueller, Associate Administrator of NASA's Office of Manned Space Flight (1963-1969)

The arrival of seven new faces in the Astronaut Office in the fall of 1969 differed from previous selections in many ways. For ten years and six selection programs, NASA had followed a clear process, with listed criteria, several rejection points, extensive interviews, and an intensive program of medical examinations. But for the Class of '69 there were none of these, as each man had already undergone that process under the USAF Manned Orbiting Laboratory (MOL) program. Only two basic selection criteria applied this time; successful applicants had to be under the age of 36, and the pool of potential candidates was strictly limited to just the 14 serving MOL astronauts. This was not a selection as such, merely a transfer of management from the USAF to NASA, the first and, to date, only time this has occurred in nearly 60 years and more than 20 classes of NASA astronaut selections.

Calling upon skills forged in their early military careers, refined in attending the Aerospace Research Pilot School (ARPS) and expanded upon by their MOL experiences, what these seven men brought to NASA and the astronaut program in the late 1960s became as important as those selected in the six classes before them. Their diversion via MOL had merely added to their wealth of talent.

D.J. Shayler, C. Burgess, *The Last of NASA's Original Pilot Astronauts*,
Springer Praxis Books, DOI 10.1007/978-3-319-51014-9_8

THE SECRET SEVEN SIGN ON

Perhaps more than any other group chosen for the NASA astronaut program, the seven transferees from MOL have the most interesting story to tell; one which was mostly hidden behind national security restrictions until 2015, when the declassified documents from the National Reconnaissance Office (NRO) finally revealed details of the secretive MOL program. In contrast to each NASA astronaut group, their announcement to the public was done with little fanfare at the time of their selections between November 1965 and June 1967. After that, little was heard of them, until MOL was cancelled in June 1969 and they were transferred to NASA.

After five years of relative obscurity, the men of NASA Group 7 were now very much in the public eye, and as the Apollo era gave way to that of the Shuttle, each would play a significant part in the transition between those programs. Just over a decade later, all seven would be assigned prominent crew places on the first six missions of the Shuttle, designed to evaluate the concept of the Space Transportation System (STS) and smooth the – perhaps premature – transition from flight tests to 'operational' service. Members of the seventh astronaut group played an active role in the atmospheric tests of the Orbiter *Enterprise*, through the orbital flight tests of *Columbia*, and for the introduction of the new vehicles named *Discovery* and *Atlantis*. The once relatively unknown names of Crippen, Truly, Fullerton, Hartsfield, Overmyer, Bobko and Peterson suddenly became familiar inclusions on Shuttle crew manifests during the first five years of the program. Not only were they at the forefront of the first few missions, many went on to achieve second or third flights, before moving on to leading administrative and managerial roles within NASA and the aerospace industry into the 1990s and in the aftermath of the *Challenger* tragedy.

The seven former MOL astronauts who made up NASA's seventh class of astronauts since 1969 were:

KAROL J. BOBKO

Karol Joseph ('Bo') Bobko holds the distinction of being the first Commander (CDR) of Space Shuttle Atlantis *(OV-104) in October 1985, for a classified Shuttle mission (STS-51J) which deployed two military communications satellites. Previously, Bobko had served as Pilot (PLT) of STS-6, the first flight of* Challenger *(OV-099) in April 1983 and then two years later as CDR of STS-51D onboard* Discovery. *After joining NASA in 1969, Bobko worked on the Skylab program, serving as a crewmember for the 56-day ground-based Skylab Medical Experiment Altitude Test (SMEAT) in 1972, followed by assignment as a support crewmember for the Apollo-Soyuz Test Project (ASTP) in 1975. During the Shuttle's Approach and Landing Test (ALT) program in 1977, he served alternately as Capcom and lead chase pilot.*

As his name would indicate, U.S. astronaut Karol Bobko has an interesting family background, with both sets of grandparents coming from neighboring countries bordering the Baltic Sea. His paternal grandparents Peter (Piotr) Bobko and the former Francis (Franciszka) Studak emigrated from Poland in the early 1900s, while his maternal grandparents, Michael (Mykolas) Sagatis and the former Petronele Gineitaite, were from the city of Kedainiai in central Lithuania.

NASA Class of 1969. (L to R): Bo Bobko, Gordon Fullerton, Hank Hartsfield, Bob Crippen, Don Peterson, Dick Truly and Bob Overmyer.

Bobko was born in New York City to Charles Peter and Veronica (née Sagatis) Bobko on December 23, 1937. It was an interesting time in America. That same year, Franklin D. Roosevelt was sworn in for his second term as U.S. President, the Golden Gate Bridge was opened in San Francisco, and beloved aviatrix Amelia Earhart was lost on her round-the-world flight.

After grade school, Bobko attended New York's Brooklyn Technical High School, where his activities away from his academic studies included the school's Services Squad, the Student Council as a Grade Council member, the Arista Honor Society and the school band. He graduated from high school in 1955.

When asked what inspired him to apply to the new U.S. Air Force Academy [USAFA], Bobko responded: "I had thought about going to West Point, but there was a lieutenant colonel that lived in our neighborhood and [he] told me about the new Air Force Academy that was being developed. So I applied and was accepted to the first class, and many of my instructors there were starting to talk about the new space program … and so that was kind of my introduction to space. And, of course, being at the Air Force Academy made me desire to become a pilot as well." [1]

The USAFA was so new that the buildings had not yet been completed, so Bobko and the other 305 cadets in the Class of 1959 were sworn in at a temporary site at Lowry Air Force Base (AFB) in Denver, Colorado, on July 11, 1955. They were housed in renovated World War II barracks. The cadet parade uniform – still worn to this day – was designed by famed Hollywood director, Cecil B. DeMille. They were the first class to adopt the strict Cadet Honor Code, and selected the falcon as the academy's mascot. Some of Bobko's other achievements at the academy were in gymnastics, making the dean's list, and being presented with the 1959 Billy Mitchell Award for Outstanding Cadet in Military Studies, as well as the 1959 Hitchcock Award as the Outstanding Cadet in Economics. On August 29, 1958, the academy moved to Colorado Springs, where the Class of 1959 graduated and its members were commissioned as second lieutenants in the U.S. Air Force on June 3, 1959. [2]

Bobko graduated 27th in the class, taking with him his bachelor of science degree in Aerospace Engineering. Once he had attained his navigator rating, he undertook pilot training at Barstow AFB, New Mexico and then at Vance AFB, Oklahoma. On completing his flight training, he received his pilot wings in 1960. Karol Bobko married the former Frances Dianne Welsh of Denver, Colorado on February 11, 1961, and they would have two children.

From 1961 to 1965, Bobko was assigned to the 523rd Tactical Fighter Squadron (the 'Crusaders') at Cannon AFB, New Mexico, and to the 336th Tactical Fighter Squadron (the 'Rocketeers') at Seymour Johnson AFB, North Carolina, flying F-100 *Super Sabre* and F-105 *Thunderchief* jet aircraft. In 1964, he attended and graduated from Squadron Officer School. [3]

With 1,500 hours of logged flight time, Capt. Bobko next attended the ARPS at Edwards AFB, California, as a member of the 12-strong Class 65C. This class was the tenth conducted by the four-year-old ARPS, in which the students would receive some 600 hours of academic instruction and 400 hours of actual or simulated flight training. The school's academic program included aerodynamics, guidance and control, celestial navigation and bioastronautics, and put theory into practice in the cockpit and during classroom instruction, thus preparing graduates as potential astronauts, or as project managers or consultants for space research programs.

Karol Bobko, Class of 1959, USAF Academy. (Courtesy USAF Academy)

In the USAFA weekly newspaper, *Falconer*, for June 24, 1966, it was proudly announced that, "For the first time, an Academy graduate has been selected to participate in a space flight program. Capt. Karol J. Bobko, a member of the Academy's first graduating class, is one of five more pilots picked for assignment to the Manned Orbiting Laboratory (MOL) program, bringing the total number of officers assigned to this project to 13." [4]

At the cancellation of MOL, Bobko elected to go back to education, and while he was one of the seven chosen to transfer to NASA in 1969, he first graduated from the University of Southern California (USC) with his master's degree in Aerospace Engineering in 1970 before joining the agency full time.

ROBERT L. CRIPPEN

Robert Crippen, known as 'Crip,' became one of the most experienced astronauts of the early Shuttle era, flying four high-profile missions in the space of 42 months. He was scheduled to make a fifth flight, until the Challenger *accident intervened. After support work on Skylab and ASTP, Crippen was assigned as PLT on the first Shuttle mission, alongside veteran CDR John W. Young. On the 20th anniversary of Yuri Gagarin's first ever manned spaceflight onboard Vostok, Crippen and Young flew Space Shuttle* Columbia *into orbit on* *a two-day test flight, thus inaugurating the Shuttle flight program. Two years later, Crippen was in command of STS-7, a satellite deployment and retrieval mission which also saw the flight of America's first woman in space, Sally Ride. The following year, Crip was back in orbit again, not once but twice; first as CDR of STS-41C, the Solar Max retrieval and repair mission, then as CDR again for STS-41G, an Earth observation mission. His fifth mission was to have been as CDR of STS-62A, the first Shuttle mission launched out of Vandenberg AFB in California, but with that mission delayed and then cancelled following the loss of* Challenger, *he moved instead to managerial positions with NASA.*

When Robert Laurel Crippen came into the world on September 11, 1937, his parents were living in Beaumont, Texas. In the first years of the 20th century, the discovery of colossal reserves of oil in that area had led to the monumental Texas oil boom, and a resultant surge in workers eager to cash in on what historians would later label the "gusher age." In the years of the Great Depression, Herbert Wesley Crippen was no different, finding employment as an oil worker until losing two fingers in an accident. With the money he received in insurance, Herb moved his young family to Porter, a small town located just north of Houston, where he had purchased a small chicken ranch. In those days, Porter had a population of around 100 and just four businesses. Once they had settled, Ruth Cynthia (née Andress) Crippen opened a combined neighborhood tavern and gas station known as Crippen's Drive-In, which she would continue to operate for the next 40 years. [5]

When Bobby (as he was known) was still quite young, his father used to drive out to nearby Hobby Airport so the boy could watch wide-eyed as airplanes took off and landed amid much noise and smoke. Around this time, his little sister Betty Lou was born, completing the Crippen family.

Bobby proved to be a good and attentive student in elementary school, with his report cards showing mostly As, and a few Bs. Crippen then moved on to New Caney High School, three miles north of Porter. He is remembered there as a bright, popular student who played the saxophone in the school band. But flying was now an ambition, as Betty Lou later recalled. "Bobby would talk about being a test pilot," she said. "He'd spend his allowance on model airplanes and he was always good with machines ... but I never thought he'd be famous." [6]

Back then, Crippen may not have entertained thoughts of being famous one day, but he had some ideas about future directions he might take. "Well, I guess most of my adult life I'd sort of worked in that direction. When I was a freshman at the University of Houston, I remember writing a paper on rockets and doing some research to do that. I spent my sophomore year up at Huntsville, Texas, at Sam Houston [State University], and it was [at] that time that the Russians put up the Sputnik [satellite]. So it was very obvious to me that before long people were going to be going into space. I'd always wanted to fly, and I guess flying higher and faster is the objective of most pilot types. So I wanted to continue working in that direction." [7]

Still with the ambition to become a military pilot, Crippen took on temporary work as a railroad switchman and served meals in a boarding house to help pay his way through college. His next move was to the University of Texas (UT) in the state capital, Austin. While studying there, he entered the Navy's Reserve Officer Training Corps (ROTC). It was also at UT that he met his first wife, Virginia Hill of Corpus Christi, whom he married on

September 8, 1959 while still in his senior year. He graduated the following year with his bachelor's degree in Aeronautical Engineering and was commissioned an ensign through the U.S. Navy's Aviation Officer Candidate School (AOCS) Program at Naval Air Station (NAS) Pensacola, Florida, where he undertook initial flight instruction at Saufley Field.

From September 1960 to November 1961, he continued his flight training at NAS Whiting Field, Florida. During this time, he was a student pilot on such aircraft as the piston-engine T-34B *Mentor*, T-28B/C *Trojan*, F9F *Panther* jet and F11F *Super Tiger* supersonic fighter aircraft. He received his Wings of Gold as a naval aviator while at NAS Chase Field in Beeville, Texas, in 1962.

His first assignment, in December 1961, was to VA-43 RAG (Replacement Air Group) Training Squadron, flying the single pilot A-4 *Skyhawk* jet at NAS Oceana, Virginia. Then, between June 1962 and November 1964, Crippen served two deployments aboard the aircraft carrier *USS Independence* (CVA-62), flying the A-4 with VA-72 ('The Blue Hawks'). These deployments took him to the Mediterranean, the North Sea and the Caribbean. During the Cuban Missile Crisis in late 1962, his squadron was briefly deployed off Gitmo on the *USS Enterprise* (CVN-65).

In December 1964, Crippen received an assignment to the Air Force's ARPS at Edwards AFB, California, then under the command of legendary test pilot Chuck Yeager. After his Class 65A graduated in 1965, Crippen remained at the base as an instructor. During his time at Edwards, he managed to fly incredibly diverse aircraft types, including the T-33A *Shooting Star*, T-38A *Talon*, F-106A/B *Delta Dart*, F-104A/B/D *Starfighter*, B-26 *Marauder*, B-47E *Stratojet*, B-57E *Canberra*, NF-100F *Super Sabre* and the Bell H-13 *Sioux* helicopter.

He was then selected in the second group of astronauts for the Air Force's MOL program. "The opportunity came to apply both to NASA and the military, because the military was doing a man in space program … I applied for both. At some point in the process, I had to decide one way or the other and ended up picking MOL, because I thought NASA had more astronauts than they knew what to do with, and the [Apollo] program, even though it hadn't started, was already starting to have some of the flights cancelled." [7]

Crippen remained at the Edwards flight school until he received his clearance for the program. He then reported to Los Angeles and began working on MOL development until, as he wryly added, "sure enough, after a couple of years on that program, it got cancelled. [I] was lucky enough to get transferred over to NASA, along with six of my cohorts that were crew members on MOL." [7]. It was during his time with MOL that he gained 'Crip' as a nickname. "I recall it occurred when I joined MOL and Bob Overmyer was in my group. I believe it was just a way to separate the two of us." [8]

CHARLES G. FULLERTON

After joining NASA in the fall of 1969, Gordon Fullerton was assigned to the support crews for Apollo 14 and Apollo 17. He also served as a Capcom for the final four Apollo lunar missions. With Apollo over and the crews selected and in training for Skylab and

ASTP, he was assigned to the new Space Shuttle program. In 1976, he was named as PLT on the first of two crews assigned to the ALT program, flying Space Shuttle prototype Enterprise *(OV-101) off the back of a converted Boeing 747 aircraft. These tests in 1977 gave him the required experience to be assigned to the Orbital Flight Test (OFT) program and in 1978 he was named to the OFT training group. In 1982, he served as PLT for STS-3, the third flight of* Columbia*, alongside CDR Jack Lousma, and three years later, he commanded STS-51F, carrying the Spacelab 2 astrophysical laboratory payload.*

Rochester, in Monroe County, is situated on the southern shore of Lake Ontario, and is part of New York State's breathtaking Finger Lakes region. It was here that Charles Gordon Fullerton was born on October 11, 1936, while America was still in the grip of the Great Depression, the first-born child of Charles Renwick Fullerton and the former Grace Sherman. Although he was named after his father, he would always be known as Gordon, or 'Gordo.' He would later be joined by two sisters, Jeanne and Ann. When war came, their father enlisted in the U.S. Army Air Force and the family moved to a new home, some 35 miles north of Pittsburgh, Pennsylvania. He could pinpoint when he first developed an interest in aviation.

"Well, it began when I was in the first three years of grade school. I lived in Butler, Pennsylvania, and my father was off in the Army Air Corps. So we heard what he was up to, where he was being based, and what airplanes he was flying, so the interest was natural there. I remember specifically, for a Christmas present, he sent me an aircraft instrument panel – 'toy' is not the word – an educational kind of toy that you could set up on a table, that had cardboard rudder pedals and a stick to fly with and a book that said how to fly, and I devoured it – I wore that thing out. So that's about as early as I can remember, and [I] remember also building, with a peach basket and a two-by-four and some skate wheels and wagon wheels, an airplane I could roll on the sidewalk, with some help from my grandfather and uncle. Pretty cool little airplane, I thought. Still have a picture of it. So that interest in airplanes was pretty firmly established as I proceeded on." [**9**]

At the end of the war, his father was discharged and the family moved to Portland, Oregon, where Gordon went into fourth grade at Beaumont School. Although his father had decided never to fly again, as a special treat for Gordon's tenth birthday he hired out an *Aeronca*, a single-engine, two-seat, light airplane, with a high wing and fixed conventional landing gear, and took his son on an exciting flight. As Fullerton recalled, it was the first (and for some years, the last) time he actually flew in an airplane. "My interests were clearly on the mathematics – scientific, technical, that's where my interests and abilities were. The idea that I would be an engineer was formed real early in high school, and so that's the kind of courses I took, and it led to going to engineering school after high school." [**9**]

After graduating from Beaumont School in 1949, Fullerton attended U.S. Grant High School in Portland, graduating in 1953. Knowing that he would like to fly, but not having any opportunity to take flying lessons, he enrolled at the California Institute of Technology (Caltech) where, on June 7, 1957, he received his bachelor of science degree in Mechanical Engineering. He elected to stay on at Caltech and continue his studies, and the following year he was awarded his master's degree, also in Mechanical Engineering.

While studying for his degrees, Fullerton also joined the Air Force ROTC. This gave him the opportunity to fly with the instructors at Caltech, who would take him along whenever they went to Norton AFB in San Bernardino, California, allowing him to experience different aircraft including a T-33 *Shooting Star* jet trainer. Prior to graduating from Caltech and receiving his ROTC commission as a second lieutenant in the Air Force, he worked as a mechanical design engineer in the Flight Test Department of the Hughes Aircraft Company in Culver City, California. He joined the U.S. Air Force on July 17, 1958.

Fullerton completed his primary and basic flight training at Bainbridge AFB, Georgia, and Webb AFB, Texas. In September 1959, he began training as an F-86 *Sabre* jet interceptor pilot at Perrin AFB, Texas and from May to December 1960, he received B-47 *Stratojet* combat crew training at McConnell AFB, Kansas. He then served as a B-47 jet bomber pilot with the 303rd Bomb Wing of Strategic Air Command (SAC) at Davis-Monthan AFB, Tucson, Arizona. [3]

These were the tense times of the Cold War and the 303rd Bomb Wing had a nuclear mission, with the pilots on constant alert and each of the B-47 aircraft loaded with a device in the bomb bay. He would remain with the Wing for four years, pulling duty at Davis-Monthan, but also in Alaska, at Fairbanks and Elmendorf. During the Cuban Missile Crisis in 1962, all of SAC went to the highest level of alert. It was a dangerous period in history, when two nuclear superpowers came close to the ultimate confrontation.

In 1964, Fullerton was selected to attend the Air Force ARPS at Edwards AFB, California, becoming a member of Class 64B. Following the class graduation in May 1965, Fullerton reported to the Aeronautical Systems Division at Wright-Patterson AFB in Dayton, Ohio, where he was assigned as a test pilot for the Bomber Operations Division. During this time, he also attended Squadron Officer School and the Industrial College of the Armed Forces, graduating from both. He then began hearing word about an exciting new Air Force project called MOL.

"Space flight was just sort of becoming a possibility. The word 'astronaut' I hadn't heard of prior to this, until it started showing up in the papers. And so that sounded pretty cool, and I applied for [both] NASA and the Air Force [MOL] program, so that I'd take either one. There were selection boards convened for both. I happened to be in the Air Force ones and then, after a lot of long involved process, [was selected in] the second group of crew members for [the] Manned Orbiting Lab." [9]

Fullerton served as a flight crewmember for the MOL program from 1966 through 1969, when the program was abruptly cancelled. During this period, he married the former Marie Jeanette Buettner of Delphos, Ohio, on July 6, 1968. MOL's cancellation left Fullerton uncertain of his future direction.

"I found an assignment [at] Edwards to test the C-5 transport airplane … It looked like an interesting, good job. But then all of a sudden, George Mueller at NASA Headquarters decided we have now fourteen semi-trained astronauts available. NASA should pick up at least some of them, and so they made an arbitrary cut in the middle and took the seven youngest, and that's it. That's how I became an astronaut, by pure quirk of fate, rather than any intense competition." [9]

HENRY W. HARTSFIELD, JR.

Hank Hartsfield fulfilled support assignments on Apollo 16 and all three Skylab missions before being assigned to the development of the Shuttle for several years, including as back-up pilot for STS-2 and 3. Assigned to the OFT group, he flew as PLT on STS-4 alongside CDR TK Mattingly, the final OFT and the first classified Shuttle mission. Hartsfield became the first CDR of Shuttle Discovery *(OV-103) when it was launched on its maiden flight, STS-41D, in August 1984. The following year, Hartsfield commanded the German Spacelab D1 science mission flown as STS-61A, after which he moved on to managerial roles at NASA for several years.*

Henry Warren Hartsfield Jr., known throughout his life as Hank, was born in Birmingham, Alabama on November 21, 1933, to Henry Warren Sr. and Alice Norma (née Sorrell) Hartsfield. His father, a self-educated bookkeeper, was an office manager for a general contractor. Hartsfield and his brother Eric grew up near a local airfield, giving them an early taste of aviation.

"I don't walk around bragging, but he's always been highly intelligent," his mother Norma Hartsfield once told a university reporter. She recalled the first time she suspected her son might be smarter than most kids his age. "He was two years old when he learned his letters," she said. "Back then, we were living in [Birmingham's] West End and we brought groceries home in cardboard boxes. The boxes had big letters on the side and Henry's grandparents taught him the alphabet from those boxes." She said his schoolteachers were quick to realize they had a prodigy on their hands. "He was double promoted four times in elementary school." [10]

When asked how his interest in aviation had first come about, Hartsfield replied, "When I was a kid, that's all I thought about, was flying. The guy my dad worked for smoked Wings cigarettes. That's an old brand that had a little picture of an airplane on every pack. [Dad] used to bring them home to me, the pictures of airplanes. I collected those cards. They're probably worth something today, but I don't know, I think I threw them away." [11] Hartsfield had taken on a job as a newsboy to earn some pocket money, and at one point he also won a free airplane ride. From that time on he was even more hooked on flying.

At the relatively young age of 16, after graduating from West End High School in 1950, he went on to Auburn University, Alabama, where he successfully applied to join the U.S. Army's ROTC Corps of Engineers program. At Auburn he was studying chemistry, but this often proved to be something of a disaster. "I was always blowing up things and catching things afire," he recalled, and so he switched to physics. [12]

When Hartsfield was in his senior year, the Air Force was looking for pilots and agreed to give a commission to graduates of other branches of ROTC if they wanted to fly. "So I took a series of tests at Maxwell Air Force Base and another base in Georgia and passed it all," he told a NASA interviewer. "They offered me the commission and I accepted it. So [when] I graduated from Auburn, I went into the Air Force instead of the Army." [11]

On graduating from college with his bachelor of science degree in Physics on June 5, 1954, Hartsfield was commissioned a second lieutenant in the U.S. Air Force. But there was a problem, as he had previously applied for graduate school, and had been accepted at Duke University in Durham, North Carolina.

"I was going into theoretical physics when I started there, but then the Air Force sent me a letter not too long after I got there, [which said] 'It's time to report to active duty.' I said, 'Whoa, wait a minute. Too soon.' So I switched over to experimental [nuclear] physics. They had an accelerator, a van de Graaff accelerator. I started doing a project to get my master's, and the Air Force delayed me until June of the following year, but not anymore past that." With the June deadline approaching, the head of the physics department agreed to write a letter to the Air Force, asking that Hartsfield be given an additional three month's tuition, but this was refused, "so I went on active duty and began to fly, and discovered I really loved flying. So I stayed in the Air Force." [**11**]

Hartsfield entered the service on June 14, 1955, and soon after began his primary flight training at Bainbridge AFB, Georgia, followed by basic training at Webb AFB, Texas. He then completed gunnery training at Williams AFB, Arizona, where he flew the F-86F *Sabre*. Once he had received his wings as a pilot, his first duty station was at Seymour Johnson AFB, North Carolina, and he would serve at several other bases over the next four years. In the meantime, on May 14, 1957, he and Judy Frances (always known as Fran) Massey, whom he had met while studying at Duke, were married. They would have two children.

More interested in the big rockets themselves than being launched on top of them, he applied to continue his graduate work at the Air Force Institute of Technology (AFIT) at Wright-Patterson AFB, Ohio, this time studying astronautics. He was accepted in 1960.

In the spring of the following year, however, he listened to radio reports of the Mercury flight of Alan Shepard, and he decided that was what he wanted to pursue. "So I started researching what it took to get into the space program. All the people that had been selected at that point had been test pilots. So I said, 'Well, I've got to go to test pilot school.' Then I find out I didn't have enough flying time. So I applied for an overseas assignment." [**11**] That assignment ended up as a tour with the 53rd Tactical Fighter Squadron at Bitburg Air Base in West Germany, from 1961-1965, flying Republic F-105 *Thunderchief* fighter jets.

After passing the 1,500-hour mark in high performance aircraft, he applied to the ARPS and was accepted on his first attempt, joining Class 64C at Edwards AFB. Among those in his class were three other future NASA astronauts; Charlie Duke, Stu Roosa and Al Worden. The class graduated in 1965 and Hartsfield stayed on at Edwards as an instructor until he was selected as a member of the second group of military astronauts for the MOL program on June 17, 1965. When MOL was cancelled four years later, just prior to the lunar mission of Apollo 11, Hartsfield was one of the seven pilots transferred to NASA, becoming a Group 7 astronaut. But a long wait was in store before he would fly into space for the first time.

Group 7 astronaut portrait images, at the time of their selection to MOL in 1965, 1966 & 1967. (Courtesy USAF)

ROBERT F. OVERMYER

Bob Overmyer was assigned to work on the design and development of the Skylab Orbital Workshop (OWS) shortly after arriving at NASA in Houston. He then worked as a support crew member and Capcom for Apollo 17, before being assigned to the ASTP support crew and as Capcom at Mission Control in Moscow during the international mission in July 1975. Two years later, he alternated as Capcom and chase pilot for the series of ALT flights of Shuttle Enterprise*, and was the Deputy Vehicle Manager for* Columbia *during the preparations for STS-1. The first of his two spaceflights came as PLT on STS-5, the first 'operational' mission in November 1982, and the second was as CDR of STS-51B, the multi-discipline scientific mission also known as Spacelab 3.*

While he would never quite achieve the fame of another U.S. Marine astronaut hailing from Ohio by the name of John Glenn, Robert F. ('Bob') Overmyer served both the Marines and NASA with pride and great distinction. Although he was born in Lorain, Ohio (also the birthplace of his mother), Overmyer always considered the Cleveland suburb of Westlake, 18 miles to the west of Lorain, to be his hometown. He once said that growing up to the sounds of low-flying aircraft from the nearby Cleveland Hopkins airport instilled in him an obsession for flying.

Born on July 14, 1936, Robert Franklyn Overmyer was the third child for Rolandus and Margaret June (née Fabian) Overmyer. He was four years younger than his sister, Carol Jean, and two younger than his brother, Richard Abian. Robert was five years old when the family moved into a house on Canterbury Road, Westlake (known until 1940 as Dover Township) and he entered Westlake School in the first grade. He also became active in the Boy Scouts of America, later achieving the rank of First Class Scout. A keen student, Overmyer would go on to attend Westlake High School.

In the summer during his high school years, he worked at Dean's Greenhouse on Porter Road, earning enough to enable him to attend college after he graduated from Westlake High, in 1954. That fall, he entered Baldwin Wallace College in Berea, Ohio, studying a science-based curriculum. [**13**] While there, he met a pretty young cheerleader named Katherine Ellen (known as 'Kit') Jones, from Mount Lebanon, Pennsylvania. They were married on October 17, 1959, and would eventually have three children.

On February 11, 1957, while still studying at Baldwin Wallace College, Overmyer enlisted in the U.S. Marines. Following his graduation from college with a bachelor of science degree in Physics, he entered active service as a commissioned second lieutenant with the Marine Corps on January 13, 1958.

After completing Navy flight training in Kingsville, Texas, he was assigned to Marine Attack Squadron 214 (VMA-214) in November 1959, then based in Hawaii, where he flew the North American FJ-4B *Fury* and Douglas A-4B *Skyhawk* jet fighter bombers. In 1962, he was sent to the Naval Postgraduate School in Monterey, California, where he attained his master's degree in Aeronautical Engineering in June 1964. After graduating, he served one year with Marine Maintenance Squadron 17 in Iwakuni, Japan. He was then assigned to the Air Force ARPS at Edwards AFB, California, joining Class 65C in August 1965. [**14**]

When his class graduated the following year, Overmyer was recruited into the second of the three MOL astronaut groups, along with Hank Hartsfield (USAF), Bob Crippen (USN), Karol Bobko (USAF) and Gordon Fullerton (USAF). Selected on June 17, 1966, they returned to the ARPS to begin training for the anticipated 30-day MOL missions, completing their initial training in January 1967. The three groups of military astronauts then continued MOL training until June 1969, when the program was abruptly cancelled due to budgetary constraints and Overmyer instead became one of NASA's Group 7 astronauts.

DONALD H. PETERSON

Don Peterson's early assignments at NASA included serving on the support crew of Apollo 16, before joining the Shuttle Branch Office of the CB. Peterson completed just one spaceflight, as a Mission Specialist (MS) on STS-6, the maiden voyage of Challenger *in April 1983, during which he and Story Musgrave completed the program's first spacewalk (Extra Vehicular Activity, or EVA) and spent four hours evaluating the new Shuttle EVA suits in the open payload bay.*

Future astronaut Donald ('Pete') Peterson came from hardy family stock. His father, Henry Walter Peterson (also known as 'Pete') was orphaned at an early age, and ran away from an orphanage when he was 13 years old. Two years later, he joined the military service, having lied about his age, and served two years with the Ambulance Service. At the end of World War I, he took a job selling Nash automobiles and met and married Mabel Rose Strickland. Now living on Summit Street in Winona, Mississippi (where they would remain for the rest of their lives), he made a living running a service station and later sold Tardy furniture. The couple's first son, Donald Herod Peterson, was born on October 22, 1933. His younger brother Gilbert was born three years later, on February 28, 1936, and would go on to become a successful singer and film and television actor. [15]

After grade school, young Don attended Winona City High School, where he discovered he had an affinity for math, physics and science. Henry Peterson said his son had always found it easy "to pick up and learn things, and he would work at anything he could to earn a little extra money." [16] Peterson later told UPI interviewer Olive Talley: "I grew up during the Second World War and there were a lot of things written in the newspapers and books about airplanes and the great fighter pilots and their exploits. That was exciting stuff." [17]

Once he had graduated from high school in 1951, and with his talent for mathematics, Peterson wanted to attend college, but financing that dream when money was short was difficult. After listening to a talk given by a Navy recruiter, he set his mind on seeking an appointment to a service academy, where college tuition was free. "I didn't really want to be in the Navy, but I decided a service career might be an interesting thing," he stated. "I managed to get accepted to go to West Point with the idea of going into the Air Force." At that time, there was no separate Air Force Academy, but attendees at West Point were given the option of joining the Air Force upon graduation. [17]

Peterson would graduate from West Point on June 7, 1955, with his bachelor of science degree. As expected, he then elected to join the U.S. Air Force and received his commission as a second lieutenant.

Having completed his cadet and advanced flight training, Peterson spent the next four years as a flight instructor and military training officer with the Air Training Command (ATC), serving with them until 1960. "I got a lot of flying time," he said of his service with the ATC, "which later on was very important because that was one of the criteria, for example, to get into test pilot school." [18]

Following that tour of duty, Peterson was asked if he would be interested in working on a new military program involving nuclear-powered aircraft. "They were looking for pilots who were willing to go back to school and get a degree in nuclear engineering, to work with an airplane that was going to be powered by a nuclear reactor. So I went back to school, and I got a master's degree, which took a couple of years at Wright-Patterson [AFB in Ohio] and about six months before I graduated, they cancelled the nuclear-powered aircraft program. So I had a master's degree in Nuclear Engineering and really no flying assignment where I could use that. I wound up working in technical intelligence at Wright-Patterson for about another three or four years." [18] He also performed further work toward a PhD at the University of Texas.

Capt. Peterson then spent a further year as a fighter pilot with Tactical Air Command, which included three months' combat weapons training, prior to being accepted as a student in Class 66B at the ARPS at Edwards AFB, California.

On June 30, 1967, following his graduation from ARPS, he was one of four aerospace research pilots selected for the MOL program. This third selection group completed their initial training at the ARPS school in January 1968, and for Peterson, the program dovetailed nicely with his career experience in flying and technical intelligence. When the MOL program was cancelled, Peterson transferred those skills to NASA as part of their Group 7 selection.

RICHARD H. TRULY

Dick Truly worked on the support crews, and completed Capcom duties, for all three Skylab flights and the ASTP mission. He was then assigned to the second ALT team with Joe Engle, test-flying the Enterprise *orbiter off the back of a converted Boeing 747. He remained teamed with Engle for the backup crew of STS-1 and prime crew of STS-2 in November 1981. Subsequently, Truly flew as CDR of STS-8 in 1983 before returning to the U.S. Navy as head of its Space Command in Virginia.*

Richard Harrison ('Dick') Truly was born in Fayette, Mississippi, on November 12, 1937. He was the first and only son for Jessie Smith Sheehan and James Bennett Truly, a Federal Trade Commission lawyer. They had married in June 1936 but were divorced sometime around 1940.

Truly attended what were then segregated schools in Fayette and Meridian (also in Mississippi), but his childhood interests did not point him towards a future in aviation, as he explained to NASA interviewer Rebecca Wright. "Well, of course, when I was a kid, I was like all other kids. I was interested in flying, [as well as] a hundred other things, built model airplanes, that kind of thing, but I never really intended to be a pilot. It just never occurred to me that that would be a possibility." [19]

He earned his bachelor of science degree in Aeronautical Engineering from the Georgia Institute of Technology, Atlanta, in 1959. As a member of the Navy ROTC at Georgia Tech, Truly was commissioned an ensign in the U.S. Navy upon graduation and sent to Beeville, Texas, for initial flight training. He was later transferred to advanced flight school at NAS Pensacola, Florida. While there, he married Colleen (Cody) Hanner of Milledgeville, Georgia, a student nurse he had met on a blind date at Georgia Tech. They would have three children.

Following his flight training, Truly was designated a naval aviator, receiving his Wings of Gold on October 7, 1960. His initial tour of duty was in Fighter Squadron 33 (VF-33), where he flew the F-8 *Crusader* aboard *USS Intrepid* (CVA-11) and *USS Enterprise* (CVN-65). By the time he left the squadron in 1963, he had achieved more than 300 carrier landings, many carried out in darkness. He was then assigned to the Air Force Test Pilot School (TPS) at Edwards AFB, California, much to his surprise. [19]

Having applied for test pilot school, Truly had written off to the Navy, expecting that if he was successful he would be sent to the Navy school at Patuxent River, Maryland. Unbeknown to him, the Navy had just initiated an exchange program with the Air Force at Edwards, so when he received his orders, he was directed to the Air Force ARPS instead.

While Truly and Cody were packing to leave VF-33 at Oceana in November 1963, after his promotion to lieutenant, they watched the funeral of assassinated President John

Kennedy on their black-and-white television set. Driving west from Oceana to Edwards, he then heard the Air Force announce that their X-20 Dyna Soar program was being cancelled and that they were instead developing a new orbital space station program called MOL. At the time, this announcement did not interest Truly. He felt that he was not qualified to be an astronaut: "I never even dreamed that I would be able to ever do something like that."

In 1964, he began test pilot training, unaware of plans to have the graduates of ARPS become future MOL astronauts. The course at that time focused upon six months of test pilot school, followed by another six-month course involving space topics such as digital computers, orbital mechanics and spacecraft systems. In December 1964, Truly graduated from the ARPS course, with only a vague inclination that his name had been shortlisted for MOL. When this was confirmed, he could not go back to the Navy before the official announcement of his selection to MOL. "So they decided to keep us at Edwards, and the Navy agreed to this, while the Air Force was waiting to announce the MOL program. They kept us at Edwards as instructors in the Aerospace Research Pilot School. So in 1965, I became a test pilot instructor.

"Then on November 12th of 1965, there was [an Air Force] press conference [in Los Angeles]. I remember that date well, because it was my 28th birthday … They formally announced the first MOL group of astronauts. It was a classified program [and] we eventually moved down to Los Angeles. The MOL Program office was located in El Segundo. So I was a MOL astronaut from that press conference until the day the program was cancelled, which all of us in the program still refer to as Black Tuesday. It was Tuesday, the tenth of June 1969.

"After that first MOL selection, a lot of other [pilots] in the Air Force really complained because they didn't get a chance to be selected. Some of them had gone to graduate school and gotten doctorates and this and that. So the Air Force changed the rules after that first selection, and then they had a formal selection where you had to apply. Then all the applications would come in, and you would be considered. They'd do a selection. And so there were a couple [more] MOL groups of [pilots] that [joined] the MOL flight crew during that period."

When MOL was cancelled, there was a discussion between NASA and the Air Force about what to do with the program's astronauts. While Director of Flight Crew Operations, Deke Slayton, felt that NASA's Astronaut Office didn't need any more personnel, he was eventually overruled and Truly joined the other six youngest selectees at NASA. Having been pre-selected for MOL, he now found himself chosen almost by default for NASA.

MOVING ON FROM MOL

After the excitement and pride of being selected for the USAF MOL program, then enduring the frustration of delayed flights and finally the bitter disappointment of the program's cancellation, these seven men were prominent in support roles for the NASA's final Apollo-era missions. For the Space Shuttle program, they were instrumental in testing the Shuttle system, helping to guide the STS concept through its initial atmospheric and orbital flight tests.

Once the Shuttle program was up and running, they paved the way for frequent flight assignments, and at least one member of their group was aboard the maiden flights of all bar one of the fleet of orbiters: *Enterprise* (Fullerton), *Columbia* (Crippen), *Challenger* (Bobko and Peterson), *Discovery* (Hartsfield) and *Atlantis* (Bobko again). The only orbiter in which none of them flew was *Endeavour*, which did not come into service until after the final member of the former MOL group had retired.

They may have had a long wait for spaceflight between 1965 and 1981, but over the next four years the group amassed a collective 17 missions out of the first 22 flights – Bobko and Peterson both flew on STS-6, the only time two Group 7 astronauts flew in space together – in the period between April 1981 and October 1985.

MOL'S TENACIOUS TEN

Apart from having an earlier birthdate than those chosen to transfer from the USAF to the NASA Astronaut Office, the rest of the MOL astronaut group were as qualified to have made the switch as the seven who did so. However, the remaining seven serving MOL astronauts did not make that transition, and some had no desire to try. Despite this, each has left his own indelible mark in Air Force and American space history. Though this book is chiefly aimed at recording the achievements of the two groups brought into NASA's astronaut program in 1966 and 1969, we have, for the sake of completeness, included a short profile for each of the seven men who did not transfer to NASA as astronauts, as well as the other three members of the MOL astronaut team, Michael Adams, John Finley and Robert Lawrence.

James A. Abrahamson (MOL III)

James Alan Abrahamson was born in Williston, North Dakota, on May 19, 1933, and grew up in Inglewood, California. In 1955, he earned a bachelor of science degree in Aeronautical Engineering from the Massachusetts Institute of Technology (MIT) and was commissioned as a second lieutenant through the ROTC in November that year. In May 1957, he completed training as a pilot at Laughlin AFB, Texas, and then completed Squadron Officer School as a distinguished graduate in 1958, subsequently serving until 1959 as an instructor, as well as in flight test and aircraft maintenance positions, with the Air Training Command (ATC) at Bryan AFB, Texas. This was followed by a second ATC at Lackland AFB, Texas. Through the Air Force Institute of Technology (AFIT) program at the University of Oklahoma, he received a master of science degree in Aerospace Engineering in 1961.

In August 1961, Abrahamson was assigned as spacecraft project officer on the VELA Nuclear Detection Satellite Program, at Los Angeles Air Force Station, California. From October 1964 to August 1965, while assigned to the 428th Tactical Fighter Squadron based at Cannon AFB, New Mexico, he served two temporary tours of duty in South East Asia, where he flew 49 combat missions.

In July 1966, following his graduation from Air Command and Staff College as a distinguished graduate, Maj. Abrahamson attended the ARPS at Edwards AFB, California, and, upon graduation as a member of Class 66B, was one of four officers selected as a

Images courtesy USAF except Lawrence, Neubeck & Taylor, courtesy Space Facts

The ten MOL pilots who did not make the NASA selection in 1969, including Adams and Lawrence (deceased 1967), and Finley (resigned 1968).

MOL Group 3 astronaut candidate. He served with the MOL program from August 1967 until it was cancelled in June 1969. Only just too old to be selected by NASA, Abrahamson instead served on the staff of the National Aeronautics and Space Council in the Executive Office of the President of the United States. In March 1971, he became manager of the TV-guided, air-to-ground *Maverick* missile program at HQ Aeronautical Systems Division, Wright-Patterson AFB, Ohio. In June 1973, he assumed command of the 4950th Test Wing, also at Wright-Patterson.

In March 1974, Abrahamson was assigned as Inspector General, Air Force Systems Command, Andrews AFB, Maryland. From May 1976 to July 1980, he served as director for the F-16 Multinational Air Combat Fighter Program, Aeronautical Systems Division at Wright-Patterson. He then became deputy chief of staff for systems at HQ Air Force Systems Command. In November 1981, just prior to the STS-2 mission, he was appointed associate administrator for the Space Transportation System at NASA HQ in Washington, D.C., responsible for guiding the nation's Space Shuttle program safely through 10 early operational missions.

Promoted on July 21, 1982, Lt. Gen. Abrahamson then served as head of the Strategic Defense Initiative Organization (SDIO), also known as the 'Star Wars' program, from 1984 until he retired from the U.S. Air Force on March 1, 1989. He then entered professional life, serving as chairman of the Oracle Corporation's board of directors between 1992-1995, and as chairman of the board of GeoEye, a company he helped to transform into the world's largest space imaging corporation and which merged with DigitalGlobe Inc., in January 2013. He has received multiple civil and professional awards during his career, including the Goddard Space Flight Award, Engineering Society's "Man of the Year" and Aviation Week's "Legends Award."

Michael J. Adams (MOL I)

Born in Sacramento, California, on May 5, 1930, Michael ('Mike') Adams graduated from Sacramento Junior College in 1950 and joined the U.S. Air Force. Following flight training, he was commissioned a second lieutenant and later flew 49 combat missions in Korea as an F-86 *Sabre* jet fighter pilot. Further assignments followed, taking him to Air Force bases in Louisiana and France, before earning his bachelor of science degree in Aeronautical Engineering from the University of Oklahoma in 1958. He then completed 18 months of graduate work at MIT.

Capt. Adams was subsequently assigned to the Air Force TPS at Edwards AFB, California, as a member of Class 62C. On graduation, he was presented with the prestigious A.B. Honts Award as the outstanding member of his class. In May 1963, he was assigned to Class 4 of the ARPS, also at Edwards, graduating in December.

In August 1963, as part of the ARPS course, Adams was with David R. Scott flying simulated X-15 approach profiles in an F-104. Suddenly the aircraft's engines failed, causing the aircraft to slam tail first into the runway. Sitting in the rear seat, Adams made an instant decision to eject, while Scott in the front seat chose to remain with the aircraft, riding out the inevitable crash. Fortunately, the aircraft did not explode and both men survived the ordeal. In the post-flight investigation, it was found that both men had made the correct decision, relying on instinct and a little luck. Had Scott ejected he would probably have been killed, as it was later found that his ejection seat system was faulty and would have only partially worked if he had activated it. If Adams had decided not to leave the aircraft, he would also probably have been killed, as the engine rammed into the rear cockpit a split second after he ejected. [**20**]

Two months later, Scott was chosen as a member of NASA's 1963 Pilot Astronaut group and went on to complete three spaceflights, including becoming the 8th man to walk on the Moon. Adams was selected as one of the first eight test pilots attached to the MOL program in November 1965. The following year, on July 20, he elected to leave the slow-moving MOL program, instead preferring to be involved in test-flying the X-15 rocket plane for which he had been simulating landings three years before. He would eventually make a total of seven flights in the X-15 (see Table 7).

Table 7 X-15 Free Flights Flown by Mike Adams 1966-1967

Adams' Free Flight	Date of Free Flight	Program Free Flight	X-15 Flown	Free Flight Time (min:sec)	Max Speed (mph/kph)	Mach	Max Altitude (feet/meters)	Adams X-15 records
1	1966 Oct 6	173*	#1	08:26.0	1,977 / 3,182	3.00	75,400 / 22,982	1st #1 free flight
2	1966 Nov 29	176	#3	07:56.2	3,120 / 5,021	4.65	92,000 / 28,042	1st #3 free flight
3	1967 Mar 22	177	#1	09:29.5	3,822 / 6,151	5.59	133,100 / 40,569	Fastest flight; highest Mach
4	1967 Apr 28	179	#1	09:15.9	3,720 / 5,987	5.44	167,200 / 50,963	
5	1967 Jun 15	182	#1	09:11.0	3,606 / 5,803	5.14	229,300 / 69,891	
6	1967 Aug 25	187	#3	07:37.0	3,115 / 5,013	4.63	84,400 / 25,725	
7	1967 Nov 15	191	#3	04:50.1	3,570 / 5,745	5.20	266,000 / 81,077	Highest altitude; Fatal Astro-flight

[*] Indicates an in-flight abort
Data courtesy, *North American X-15, Owners Workshop Manual*, David Baker, Haynes Publishing, 2016

Adams with the X-15. [Inset] the X-15 crash site of November 15, 1967.

On November 15, 1967, Adams, then aged 37, flew X-15-3 to an altitude of 266,000 feet, or 50.4 statute miles, thus (posthumously) qualifying him for U.S. Air Force Astronaut Wings. Unfortunately, the X-15 veered off course at this time and went into violent maneuvers which Adams was unable to control. The winged airplane broke apart under this enormous stress and disintegrated, killing the pilot. [21] Maj. Adams was buried five days later at Memorial Park Cemetery in Monroe, Louisiana.

Albert H. Crews, Jr. (MOL I)

Albert Hardin Crews Jr. was born in El Dorado, Arkansas, on March 23, 1929. In 1950, he graduated from the University of Southwestern Louisiana with a bachelor of science degree in Chemical Engineering. Three months after graduation he was drafted by the U.S. Army, but as he had grown up near an Air Force base, he decided to join that service instead. He went into aviation cadet training, was awarded his wings and received a commission as a second lieutenant in the USAF. After training to become a jet pilot, he joined a squadron and was posted to Wheelus AFB in Tripoli, Libya. On his return 30 months later, he was assigned to Travis AFB, California, flying an F-86L *Sabre* jet fighter. Wishing to remain in the Air Force, he applied to go back to school and was sent to the AFIT at Wright-Patterson AFB, Ohio, graduating two years later with his master's degree in Aeronautical Engineering.

Capt. Crews was accepted into TPS Class 60B at Edwards AFB, and after graduating, he would remain at Edwards for a further two years before being named as one of six pilots assigned to the clandestine X-20 Dyna Soar program on April 20, 1962. Less than two years later, the X-20 project was cancelled on December 10, 1963, with the Air Force instead developing the MOL program. Crews was one of the first eight pilots assigned to MOL and was the only one of the six Dyna Soar astronauts to join the new top-secret program.

When MOL was also cancelled, in 1969, Crews joined NASA, though not as an astronaut. He joined Flight Crew Operations at MSC Houston in June 1969, where he worked as a test pilot until retiring with the rank of colonel from NASA and the Air Force in 1994, aged 65.

John L. Finley (MOL I)

John Lawrence Finley was born on December 22, 1935 in Winchester, Massachusetts. After graduating from Culver Military Academy in 1953, he entered the U.S. Naval Academy, graduating in 1957 with a bachelor of science degree. He then entered flight training in Pensacola, Florida, and was designated a naval aviator in August 1958. His first assignment was with Air Training Unit 203 at NAS Chase Field, Texas, after which he was transferred to Fighter Squadron 51 (VF-51) on board the aircraft carrier *USS Ticonderoga* (CV-14), flying F-8 *Crusader* aircraft. After four years, he was reassigned to the staff of Carrier Air Wing Five (CVW-5) as the senior Landing Signal Officer (LSO) responsible for the safety of carrier landings by the wing's assigned aircraft and pilots. In 1964, Lt. Finley was assigned to Edwards AFB as a student test pilot with Class 64A. Following graduation, he would remain at Edwards as a flight instructor until he was selected for the MOL program.

By the time the MOL program was abandoned in June 1969, Finley had already been gone from the program for over a year, reassigned at his own request to operational flying duty with the U.S. Navy. During his service career, he earned several meritorious awards, including multiple Distinguished Flying Crosses (DFC), Strike Flight Air Medals and Navy Commendation medals for action in combat during the Vietnam War. He assumed command of class fleet oiler *USS Kawishiwi* (AO-146) on April 16, 1977.

Finley retired from the U.S. Navy in May 1980 with the rank of captain, having amassed over 1,000 carrier landings. He spent the next 15 years in executive roles with Federal Express, and later became COO/CEO with Dee Howard Aircraft Maintenance in San Antonio, Texas. He died aged 71, on September 19, 2006 in Memphis, Tennessee, of complications following a lengthy battle with diabetes.

Robert T. Herres (MOL III)

Robert Tralles Herres was born in Denver, Colorado, on December 1, 1932. He attended East High School before being enrolled at the U.S. Naval Academy, graduating with a bachelor of science degree on June 4, 1954. He then elected to join the U.S. Air Force. After flight training at Webb AFB, Texas, his early assignments (1955-1958) were in fighter-interceptors, first as a pilot and then as an air electronics maintenance officer with the 93rd Fighter Interceptor Squadron at Kirtland AFB, New Mexico. Upon graduation from the AFIT in 1960, he became an intelligence officer with the U.S. European Command Electronic Intelligence Center, stationed at Lindsey Air Base, West Germany.

Returning to the United States, Herres attended the Air Command and Staff College at Maxwell AFB, Alabama in 1965. He then joined the Air University staff to instruct in weapons employment planning until entering training as a lieutenant colonel in Class 66B of the ARPS at Edwards AFB, California. In August 1967, he was assigned to the MOL program at the Space Systems Division of Air Force Systems Command in Los Angeles as a crewmember and chief of the Flight Crew Division. After the program was cancelled in 1969, he returned to the Flight Test Center at Edwards, where he served as deputy chief of staff for plans and requirements. He left Edwards in August 1970 to attend the Industrial College of the Armed Forces at Fort McNair, Washington D.C.

In June 1971, Herres became vice commander of the 449th Bombardment Wing at Kincheloe AFB, Michigan, taking command of the Wing the following year. In April 1973, he was assigned to duties in South East Asia as commander of the 310th Strategic Wing, based at U-Tapao Royal Thai Naval Airfield, Thailand until September 1973, when he returned to Kincheloe to resume command of the 449th. From March 1974 to June 1979, he served in various positions in the command and control systems discipline at HQ Strategic Air Command (SAC), the Electronic Systems Division of Air Force Systems Command, and HQ, U.S. Air Force.

In 1979, Herres became commander of the USAF Communications Command at Scott AFB, Illinois, and two years later assumed command of SAC's 8th Air Force at Barksdale AFB, Louisiana. In October 1982, he became the director for command, control and communications systems, Organization of the Joint Chiefs of Staff, in Washington D.C. Two years later, in July 1984, he was assigned to Peterson AFB, Colorado, as commander-in-chief of the North American Aerospace Defense Command and commander of the U.S. Air Force Space Command. He was promoted to the rank of general on August 1, 1984, and became the first commander-in-chief of the unified U.S. Space Command upon its activation in September 1985. He was appointed vice-chairman of the Joint Chiefs of Staff on February 7, 1987. Gen. Herres retired from the U.S. Air Force on February 1, 1990. He died on July 24, 2008, aged 75, after a two-year battle with brain cancer.

Robert H. Lawrence, Jr. (MOL III)

Maj. Robert Henry Lawrence, Jr. was the first African-American to be chosen as an astronaut by either NASA or the military. Born in Chicago, Illinois, on October 2, 1935, he graduated in the top ten percent of students from Englewood High School and then attended Bradley University, where he joined the Air Force ROTC program, became a cadet commander, and later graduated with a bachelor of science degree in Chemistry. On graduation from Bradley, he was commissioned a second lieutenant in the Air Force Reserve. He entered flight training in Missouri in 1956 and was subsequently posted to West Germany as a fighter pilot/instructor on Lockheed T-33 *Shooting Star* jet aircraft.

Following his return to the United States in 1961, Lawrence attended Ohio State University, graduating in 1965 with a PhD in Nuclear Chemistry. He then entered the AFIT at Wright-Patterson AFB, Ohio, subsequently becoming a nuclear research officer at

Kirtland AFB, New Mexico. He was assigned to the ARPS at Edwards AFB as a member of Class 66B, from which he graduated in June 1967 and was selected for the MOL program.

All MOL graduates of the ARPS then had to enroll in an extensive six-month course. On December 8, 1967, Maj. Lawrence was in the back seat of an F-104D piloted by ARPS Operations Chief Maj. Harvey Royer, simulating high-speed spacecraft landings. Maj. Royer misjudged his approach and hit the runway too hard. The landing gear collapsed, and the aircraft caught fire and rolled. Both pilots ejected, but while Royer survived, Maj. Lawrence was killed when he ejected sideways, not upward, as the aircraft tumbled. He was aged 32.

Had he lived, Lawrence, at 33, would have been eligible for the MOL astronaut group assigned to NASA in August 1969 following the military program's cancellation. Like them, he would almost certainly have flown Space Shuttle missions. During his brief military career, Maj. Lawrence earned the Air Force Commendation Medal, and the Outstanding Unit Citation.

Richard E. Lawyer (MOL I)

Born in Los Angeles, on November 8, 1932, Richard Earl ('Dick') Lawyer graduated from high school in Inglewood, California. He subsequently earned his bachelor of science degree in Aeronautical Engineering from the University of California, Berkeley. On January 28, 1955, having participated in the ROTC over four years at college, he entered the U.S. Air Force and began initial flight training.

From 1956 to 1963, Lawyer served with the Tactical Air Command, which included 30 months stationed in the Japanese prefecture of Okinawa. From 1958 to December 1960, he was with the 336th and 334th Tactical Fighter Squadrons of the 4th Tactical Fighter Wing, during which time his squadron was selected to become involved in flight testing the Republic F-105B *Thunderchief* supersonic fighter-bomber. He also served a short tour of duty in South East Asia, flying a Cessna L-19 "*Bird Dog*" light aircraft on enemy-spotting reconnaissance missions.

In 1963, Capt. Lawyer attended the Air Force ARPS at Edwards AFB, graduating with class 63A and receiving the school's A.B. Honts Award as the outstanding member of his class for academic achievement and flying excellence. He would remain at the ARPS as an instructor until he was chosen as one of the first eight pilots to enter the MOL program. Those chosen went back into intensive aerospace and astronaut training with the ARPS and graduated in July 1966.

Following the cancellation of MOL in June 1969, Lawyer returned to active duty in the Air Force. He served a second tour later in the Vietnam War as an F-4 *Phantom* pilot and was involved in *Operation Linebacker*, the codename given to a U.S. Seventh Air Force and U.S. Navy Task Force 77 air interdiction campaign conducted against the Democratic Republic of Vietnam from May 9 to October 23, 1972. He later became deputy commander of operations.

Although he retired from the U.S. Air Force as a colonel in 1982, Lawyer continued flying and teaching others to fly for the rest of his life. He became a flight-test manager at Martin-Marietta (now Lockheed Martin), where he also helped run a successful program to create an infrared guidance system for night-time flying used in the F-16 and other fighter jets. He then worked as a commercial test pilot for a number of firms at the Mojave

Airport and Spaceport, including the National Test Pilot School. He later became chief test pilot for Flight Systems, Inc. On November 12, 2005, just four days after his 73rd birthday, Lawyer died suddenly in his Palmdale, California home of a suspected blood clot, not long after returning from a hunting trip. Col. Richard Lawyer, USAF (Ret.) was buried with full military honors at Arlington National Cemetery on January 5, 2006.

Lachlan Macleay, (MOL I)

Lachlan ('Mac') Macleay was born in Saint Louis, Missouri, on June 13, 1931. His infant years were spent in Kirkwood, Missouri, before his family moved to Redlands, California, where he graduated from high school in 1949. He began attending the University of Missouri before receiving an appointment to attend the United States Naval Academy (USNA) at Annapolis, Maryland. He graduated from the academy on June 4, 1954 with a bachelor of science degree in Electrical Engineering. He had finished 40th in his class of 856 midshipmen.

Although a USNA graduate, he chose to begin his career in the U.S. Air Force and received his commission as a second lieutenant. After pilot training, he served from 1955 to 1959 as an all-weather interceptor flight instructor in the F-86D *Sabre* jet fighter at Moody AFB in Valdosta, Georgia. In 1958, he also attended and graduated from the Squadron Officer School.

In August 1960, Capt. Macleay received orders to attend the U.S. Air Force TPS as a member of Class 60A. Once the class had graduated, he stayed on at Edwards for another year as a U-2 test pilot. From 1961-1962, he then served as an operations fighter adviser to the 10th Korean Fighter Wing of the South Korean Air Force. He took the opportunity to further his education by graduating from the Air Command and Staff College (by correspondence) in 1962.

Macleay then returned to Edwards in May 1963 to participate in the ARPS, as the youngest member of Class IV. Three future NASA astronauts, David Scott, Jim Irwin, and Ted Freeman, were in his class, which graduated the following December. During their seven months with the ARPS, the class received space-related training and instruction – the final ARPS group to do so – and when they completed the course, they became military astronaut-designees subject to selection for future manned research programs. Following on from ARPS, Macleay became a project pilot for the F-4C *Phantom* and Northrop's F-5 *Tiger* systems evaluation, as well as an operations officer for the F-5 Norway Category II/III Joint Test Force.

On November 12, 1965, Macleay was selected as one of the first group of military astronaut-designees for the MOL project, completing his training for this program in July 1966. When the MOL program was cancelled in May 1969, he was almost 38 and therefore ineligible to transfer over to the civilian NASA space program. Instead, he enrolled at the University of Southern California, achieving his master's degree in Business Administration the following year.

Macleay continued flying for the Air Force and served a combat tour as commander of the 23rd Tactical Air Support Squadron (TASS), based at Nakhon Phanom, Thailand, from 1970 to 1971. The 23rd TASS, flying the OV-10 *Bronco* under the call sign "*Nail*," served as forward air controllers, directing air strikes against enemy troops. During that assignment, he flew 150 combat missions in South East Asia. His airplane was hit twice in that time, but in the 12 months he commanded the 23rd TASS, not a single airman was lost. He returned to the United States in 1972 to become reconnaissance/strike project officer at Wright-Patterson AFB, Ohio. Over the next two years, he attended the Air War College, before returning to Wright-Patterson as director of the *Maverick* cruise missile system program office.

Prior to his retirement from the U.S. Air Force on May 1, 1978, Col. Macleay was serving as the assistant deputy chief of staff for requirements, Tactical Air Command, Langley AFB, Virginia. Following his retirement, he joined Hughes Aircraft in Tucson, Arizona, where he worked on a series of missile systems. He currently resides in Colorado Springs, Colorado.

Francis G. Neubeck (MOL I)

A third-generation Washingtonian, Francis G. ('Greg') Neubeck was born in Washington D.C., on April 11, 1932. After attending Sullivan's Naval Preparatory School, Neubeck entered the USNA, graduating as a midshipman and with a bachelor of science degree on June 3, 1955, having finished 515th out of a class of 742. When some of the graduates were offered the choice of joining the U.S. Air Force instead of remaining with the Navy, he decided to take up that option and was commissioned a second lieutenant. After completing flight training, Neubeck worked for a time on the development of weapons systems for jet fighters at Eglin AFB in Florida, also serving as a flight instructor.

After promotion to captain, he arrived at the USAF Experimental TPS at Edwards AFB on August 29, 1960, as a member of Class 60C, with a 32-week program ahead of him. Also in this class were future NASA astronauts Frank Borman, Mike Collins, Jim Irwin and Tom Stafford. The 14 class members were taught the extreme parameters of test flying, beginning with basic instruction in a dated Northrop T-28 *Trojan*, before eventually moving on to more high-performance aircraft such as the F-86, the B-57 jet bomber, the T-33 (in which Neubeck had already notched up 3,000 hours) and, for their final test work, the supersonic Lockheed F-104 *Starfighter*. After graduating on April 21, 1961, Neubeck would remain at the pilot school as an instructor, along with fellow captain and classmate Frank Borman.

On October 23, 1962, it was announced that Capt. Neubeck, then stationed at Eglin AFB, had been selected to begin training for future military space missions with the ARPS at Edwards. Here, he would team up again with Mike Collins, as well as three other future NASA astronauts, Charlie Bassett, Joe Engle and Ed Givens. During this period, he underwent testing for NASA's Group 2 astronaut selection, but missed the final cut of nine. The ARPS class would graduate as U.S. Air Force astronaut candidates in May 1963. Just a few days later, on June 5, NASA officially announced it was seeking a third group of astronauts, with Bassett, Collins and Alfred Uhalt from the ARPS class applying to the space agency. This time, Neubeck elected to remain with the Air Force and its proposed space programs.

On November 12, 1965, and, now with 4,600 hours of jet flying time behind him, Neubeck was selected as one of the eight proposed aerospace research pilots to train for the projected month-long Earth-orbital missions under the new MOL program. The eight men would undergo far more extensive ARPS training at Edwards before graduating in July 1966. Almost three years later, in June 1969, MOL was abruptly terminated before any of the pilots had a chance to fly into space. Acutely disappointed, Neubeck returned to regular flight duties with the Air Force.

In 1972, he earned a master's degree in Business Administration from Auburn University in Alabama, Georgia. In 1973, following a combat tour with the 7th Air Force in South East Asia, flying the F-4 *Phantom* out of Ubon Royal Thai AFB in Thailand, Neubeck was appointed deputy commander for test and evaluation at the Air Defense Weapon Center at Tyndall AFB, Florida. He subsequently served as assistant deputy chief of staff for requirements at Headquarters, Tactical Air Command, stationed at Langley AFB, Virginia. Finally, he became vice-commander of the Tactical Air War Center at Eglin AFB, until he left the USAF with the rank of colonel in 1982 having notched up over 7,000 hours of flight time.

In 1985, Neubeck became a technical consulting aerospace engineer in his resident state of Florida and began attending law school in order to pursue a new career in politics. He also wrote a textbook on missile design and another book on the nation's economy. The following year, he ran for office as the Republican nominee for the U.S. House of Representatives from Florida's 1st Congressional District, but failed to be elected. Today, he remains an aerospace engineering consultant.

James M. Taylor (MOL I)

James Taylor was born on November 27, 1930, in the curiously-named town of Stamps, in Lafayette County, southern Arkansas. In fact, the postmaster there once said that it was the only town in the United States that "stamps 'Stamps' on stamps."

In 1950, Taylor was awarded his Associate of Arts (A.A.) degree from Southern State University in Magnolia, Arkansas. The A.A. degree provides the first two years of study toward a bachelor's degree. On January 9, 1951, aged 20, he enlisted in the U.S. Air Force and became an aviation cadet the following year. Following pilot training, he was awarded his wings as an Air Force pilot on March 16, 1953. He then served as a fighter pilot with the Air Defense Command. Taylor later continued his formal education at the University of Michigan in Ann Arbor, graduating in 1959 with a bachelor of science degree in Electrical Engineering. That same year, he also completed the Squadron Officers Course at Air University, Maxwell AFB, Alabama.

In 1963, Capt. Taylor was assigned to Class 63A with the Air Force TPS at Edwards AFB. After graduating the following year, he was stationed with his family at Holloman AFB, New Mexico, working in Holloman's Special Weapons Test Center. Over the next year, he flew as project officer and test pilot for the F-106 *Delta Dart*, developing the Hughes Aircraft Corporation's MA-1 fire-control system. By this time, he had logged around 4,200 hours in such diverse aircraft as the F-100 *Super Sabre*, F-101 *Voodoo*, KC-135 *Stratotanker* and the T-38 *Talon*.

On November 12, 1965, Maj. Taylor was appointed to the MOL program along with seven other test pilots. After they had graduated from the ARPS school at Edwards, he spent the next three years involved in preparations for the first crewed mission. Had the MOL schedule been followed, the first orbital mission – lasting a planned four weeks – would have lifted off on February 1, 1972. Taylor is understood to be one of the two pilots selected to fly that first mission. Full crewing lists for MOL have never been defined, as far as the authors are aware, because missions were prone to slipping before crews could be assigned.

After the MOL program was cancelled and having been further promoted to lieutenant colonel, Taylor was offered the chance to become deputy commandant of the TPS at Edwards, which he accepted. He continued his USAF career in that role and as an instructor at the school.

On September 4, 1970, Lt. Col. James Taylor and Capt. Pierre J. du Bucq, a French Air Force exchange test pilot trainee, were killed when their T-38 aircraft crashed during a training exercise at Palmdale Regional Airport. They had flown to 35,000 ft. (10,668 m) out of Edwards and completed a sequence of aerobatics before requesting permission from Palmdale tower to conduct a series of touch-and-go landings on their runway. The fatal crash was caused by severe wake turbulence from a C-141 that was also performing touch-and-go exercises. On final approach, the T-38 suddenly encountered this turbulence, flipped over, and crashed 1,000 ft. (304.8 m) short of the end of the runway. Fire crews were quickly on the scene to extinguish the flames, but both men had died in the crash.

Attended by his fellow MOL astronauts, Taylor, who was 39, was buried in the Base Memorial Grove at McChord AFB in in Pierce County, Washington. He was survived by his wife, the former Jacquelyn King from Seattle, Washington, and their three children.

In memory of Lt. Col. Taylor, the TPS instituted the James M. Taylor Award, given to the outstanding graduate of the Experimental Test Pilot Course (Phase I). However, the award was discontinued after class 71B, when the school's curriculum was revised to eliminate the Phase I and II designation.

Close, but not close enough

After the disappointment of not making it into space with MOL and after so many years of delays and frustrations, rejection by NASA as well could have been a bitter pill to swallow. Some, like Jim Abrahamson and Al Crews, clearly would have loved to have joined their colleagues in the Astronaut Office at NASA, while others were less enthusiastic and returned to very successful mainline military careers. Of the three who were not there at the demise of MOL in 1969, Mike Adams had left early and transferred to the X-15 program, and while he would attain his 'astronaut wings' on his seventh and final X-15 flight, he also lost his life. Had he lived, he would have been out of the MOL program for three years by the time it ended, and thus ineligible for transfer. John Finley had also made a career choice and returned to the U.S. Navy. Like Adams, he would not have been in a position to move to NASA even if he wanted to. It might have been very different for Robert Lawrence, who was within the age limit set by NASA, but we will never know.

SUMMARY

The story of the mid-1960s astronaut selections of both NASA and the USAF had, by 1969, come full circle. Those who were chosen for MOL rather than by NASA, and who were of the right age, found themselves at the civilian agency after all at the close of the decade. Barely a month after Apollo had achieved its primary goal of landing on the Moon and returning the crew safely to Earth, the MOL astronauts suddenly now had to catch up with the civilian space program, while remaining secretive about the program they had just left. As the 1970s dawned there were new horizons to explore, and for the seven members of the Class of 1969, this meant another long wait to reach orbit. It would not be on a modified Gemini, nor in an Apollo spacecraft, but, eventually, on a Space Shuttle.

References

1. Karol Bobko: interview by Summer Chick Bergen for NASA's Oral History Project, Houston, Texas, February 12, 2002
2. Wikipedia online encyclopedia, *United States Air Force Academy*, available online at: https://en.wikipedia.org/wiki/United_States_Air_Force_Academy. Last accessed March 22, 2016
3. ***Men and Women of Space***, Douglas B. Hawthorne, Univelt Inc. Publication, San Diego, California, 1992
4. *USAFA Graduate Selected for Space Flight Program*, U.S. Air Force Academy *Falconer*, issue June 24, 1966
5. ***Into the Black***, Rowland White, Random House, New York, NY, 2016
6. *The Paris News* newspaper (Paris, Texas) article, "*A Heck of a Frequent Flyer*," issue January 26, 1986, p. 43
7. Robert Crippen: interview by Rebecca Wright for NASA's Oral History Project, Houston, Texas, May 26, 2006
8. Email to author David J. Shayler from Bob Crippen, November 28, 2016
9. C. Gordon Fullerton: interview by Rebecca Wright for NASA's Oral History Project, NASA Dryden Flight Research Center, May 6, 2002
10. Paige Lichtenstein, *Kaleidoscope* newsletter, University of Alabama at Birmingham, issue April 15, 1986
11. Hank Hartsfield: interview by Carol Butler for NASA's Oral History Project, Houston, Texas, June 12, 2001
12. *Henry Hank Hartsfield – Obituary*, The U.K. *Daily Telegraph* newspaper, issue July 24, 2014
13. Westlake Historical Society, Westlake Ohio, *Col. Robert F. Overmyer*, available at: http://www.westlakeohiohistory.org/bob.html. Last accessed March 5, 2016
14. NASA Biological Data, *Robert F. Overmyer (Colonel, USMC, Ret.)*, NASA JSC, Houston, Texas, August 1996
15. Wikipedia online encyclopedia entry, *Gil Peterson*, available online at: https://en.wikipedia.org/wiki/Gil_Peterson. Last accessed September 21, 2016
16. *Astronaut's Elderly Parents to Watch Shuttle Launch*, The *Gadsden Times* newspaper (Alabama) article, issue April 3, 1983, p. 3
17. *For Don Peterson, science fiction becomes reality*, Olive Talley, UPI Archives, March 26, 1983
18. Donald H. Peterson: interview by Jennifer Ross-Nazzal for NASA's Oral History Project, Houston, Texas, November 14, 2002
19. Wikipedia online encyclopedia entry, *Richard H. Truly*, available online at: https://en.wikipedia.org/wiki/Richard_H._Truly. Last Accessed April 2, 2016
20. ***Disasters and Accidents in Manned Spaceflight***, David J. Shayler, Springer-Praxis, 2000 pp. 78-79; also, ***Two Sides of the Moon***, David Scott and Alexei Leonov, Simon & Schuster, 2004, pp. 69-76
21. ***Disasters and Accidents in Manned Spaceflight***, David J. Shayler, Springer-Praxis, 2000, pp. 49-62

9

Where blue skies turn black

"Talk about being a spaceman? This is it!"
Ron Evans, Apollo 17 CMP,
during his trans-Earth EVA, December 17, 1972.

Those eight short words aptly sum up the excitement, relief and satisfaction for an astronaut at finally being able to ply their trade after years of training. As NASA astronauts, the achievements of each of the seventeen remaining members of the NASA Class of '66 and the seven former MOL Class of '69 are impressive, though the time between selection and flying their first mission into space varied considerably. For Dick Truly, the only member of the first MOL selection of November 1965 to make it into orbit, it was a sixteen year wait before finally leaving the launch pad. His MOL colleagues who had moved across to NASA with him in 1969 also endured a long wait for a flight. Over a two-year period, between April 1981 and April 1983, each would make their maiden spaceflight aboard the Space Shuttle, with six of the seven going on to complete their second, third or fourth flights by October 1985.

For NASA's fifth group of astronauts, the duration of their wait for a first flight was more varied. Jack Swigert and Fred Haise launched on Apollo 13 only four years after their selection, jointly becoming the first from their group to fly in space. Don Lind, on the other hand, had to wait 19 years to finally gain his astronaut accreditation, flying on STS-51B/Spacelab 3 in 1985 and becoming the last of that group to leave Earth for the first time. Of the seventeen members of the 1966 group that remained at the beginning of 1970, fourteen would make their entry into orbit on an Apollo-era mission. Only three of these fourteen would remain with NASA long enough to fly again on a Shuttle mission, while the remaining trio from the group had to wait for the Shuttle before making their orbital debut.

Of the 24 men who journeyed to the Moon on Apollo between 1968 and 1972, nine were from the fifth group (the most group representatives). Three of them (Mitchell, Irwin and Duke) became 'Moonwalkers,' while another three (Worden, Mattingly and Evans) were the CM Pilots from the final Apollo missions, credited with the conducting the first

D.J. Shayler, C. Burgess, *The Last of NASA's Original Pilot Astronauts*,
Springer Praxis Books, DOI 10.1007/978-3-319-51014-9_9

'deep space' EVAs during the trans-Earth coast. On Skylab, each of the four members from the fifth group who flew to the workshop completed EVAs (Weitz, Lousma, Carr and Pogue), but only Bruce McCandless from the Class of '66 completed an EVA from the Shuttle, in February 1984 after waiting nearly eighteen years for his first flight. From the Class of '69, only Don Peterson completed a spacewalk, participating in the first EVA from a Shuttle orbiter during STS-6 in April 1983.

During the Apollo era (1968-1975), nine Group 5 astronauts flew in the position of Command Module Pilot (CMP) and a further four flew as Lunar Module Pilot (LMP), but only Jerry Carr flew as Commander (CDR) on his first and only spaceflight. Had the Apollo lunar and Skylab Earth orbital programs run their course as originally planned, it is highly possible that we would have seen more of these astronauts progress from CMP/LMP on their first flight to CDR on subsequent missions, but this was not to be. Lousma, Mattingly, Brand and Weitz, the four veterans who remained at NASA long enough to be assigned to Shuttle crews, all flew their subsequent missions as CDR, as did Joe Engle, who had to wait for the Shuttle program to finally make it to orbit, despite having earned his 'astro-wings' flying the X-15 to the fringe of space prior to joining NASA. McCandless and Lind, who had been chosen as 'pilot-astronauts' and were eligible to fly the Space Shuttle, never got to operate as a pilot, flying instead under the alternative category of Mission Specialist (MS). Six of the 'MOL-Guys' did fly as a Shuttle Pilot (PLT) on their first missions before progressing to command each of their second missions. The exception was Don Peterson, who completed his only mission as an MS.

Eventually of course, there came a time for each of the Group 5 members to move on to pastures new. Departures from the Astronaut Office, fortunately by natural attrition rather than tragedy, began in 1972 with Jim Irwin, followed by Worden and Mitchell later that same year. Three years later in 1975, with no further Apollo flights and a long gap before the Shuttle would fly, Bill Pogue was next to leave. He rejoined the next year before leaving again, this time permanently, in 1978. By then, another five of the group (Roosa, Duke, Evans, Carr and Swigert) had retired. Haise then followed suit in 1979, the last of the selection to leave prior to the start of Shuttle flights.

In 1983, Dick Truly became the first to leave from the seventh group, less than a month after completing his second mission. His departure was around the same time as several of the still-active astronauts from the two groups moved into managerial roles following their second, third or fourth flights, just before the program's hiatus following the *Challenger* accident in January 1986. By 1990, with the Shuttle having been flying again for over 15 months, only McCandless and Brand of the Group 5 astronauts remained on the active list, and all seven of the 1969 astronauts had departed. Both of these men flew their final missions that same year, before finally leaving the Office for new horizons. In 1992, after 26 years, Vance Brand became the last member of the NASA Pilot Astronaut Classes of '66 and '69 to finally 'hang up his spacesuit' and depart the Astronaut Office, passing the baton to the next generation of astronauts, the first to have been chosen during the Shuttle era.

Across 20 years and 43 missions, these 24 astronauts logged an impressive record of accomplishments in space. They had occupied nine flight seats on Apollo, four seats on Skylab, one of the three places on Apollo-Soyuz, and 29 crew seats during the early Shuttle program. It is not the purpose of this current work to detail all the activities of these men on those missions; that task has been covered elsewhere. For the purpose of this work, the authors have summarized the main events and achievements from each flight and the activities of both groups as a whole. These two dozen individuals were the last original pilot astronauts selected by NASA in the first decade of human spaceflight (1961-1970), whose achievements spanned the second (1971-1980) and third (1981-1990) decades of that adventure. But their contributions followed an uncertain start, in the early days of 1970.

DAWN OF A NEW ERA

On January 4, 1970, NASA reported that the tenth planned lunar landing mission, Apollo 20, had been cancelled. The completed hardware had been allocated to other programs, or placed in storage, and delivery of the remaining items had been suspended. The first two stages of the Saturn V intended for Apollo 20 would be used instead to launch the first unmanned, pre-fitted-out third stage OWS, under the Apollo Applications Program (AAP).

The decision had actually been made the previous month, looking to save costs, but with the main hardware already built and paid for, the cost savings would instead come from not having to train a lunar crew, provide wages for a team at the Cape to prepare the hardware, fund the three teams of flight controllers and support staff in mission control, or reimburse the U.S. Navy for recovery operations at the end of the mission. It also alleviated the need for an additional Saturn V to launch the unmanned workshop, which would have been difficult as the production line for the launch vehicle had long since been terminated, the decision being implemented during the summer of 1967.

This decision to cut one of the Moon landing missions also cost three flight seats and two opportunities to walk on the Moon for its CDR and LMP. There has been conjecture for years over who might have been assigned to the flight, as it was far too early to name a ‘crew’ officially. However, it is generally accepted that PJ Weitz (as CMP) and Jack Lousma (LMP) were strong contenders for the positions. However, both astronauts have always stated that nothing official was ever revealed to either of them and NASA had given no formal confirmation. Given their subsequent move to Skylab, it seems likely that they were in contention and would probably have been named as backups for Apollo 17 first, before moving on to Apollo 20.

The choice of CDR is far more a subject for conjecture. It has become known that while it was possible for an experienced LMP to command a later flight (as with Gene Cernan) and participate in two lunar *landing* missions, a CDR would not be chosen to return to the surface a second time. Therefore, it is unlikely that Pete Conrad would have commanded Apollo 20, as some sources have suggested. However, it is highly likely that Fred Haise could have landed on the Moon as LMP on Apollo 13, and then returned as CDR of Apollo 19, had events turned out as originally planned.

As Haise commented: “When I was assigned after Apollo 13 as the back-up commander to John Young [Apollo 16], it was the start of my training cycle to eventually fly Apollo 19. I had Bill Pogue assigned as the CMP and Jerry Carr as the LMP. However, in September of 1970, the last two missions were cancelled, which was another disappointment for me [after Apollo 13]. At that time, Stuart Roosa and Ed Mitchell were assigned to join me in fulfilling the ‘deadhead’ back-up crew assignment. That is a long way of saying that no-one actually started the specific training on the Apollo 18 or 19 missions.” [1]

According to research by American author Mike Cassutt, Deke Slayton prioritized the recycling of experienced Apollo crewmembers from the early missions to subsequent, more demanding landing missions, thus ensuring that at least one person on the crew (ideally, the CDR) had spaceflight experience. [2] It was also part of Slayton's 'crewing system' to promote a CMP (formerly known as the *Senior* Pilot) to a backup command position and then, three missions later, to CDR. This was the process followed by Jim Lovell on Apollo 8, 11 and 13 (originally 14), Dave Scott on Apollo 9, 12 and 15, and John Young on Apollo 10, 13 and 16, as well as Dick Gordon on Apollo 9, 12, 15 and what should have been Apollo 18. Following this practice, therefore, another a strong contender for Apollo 17/20 would have been Apollo 14 CMP and Group 5 astronaut Stu Roosa. However, as Apollo continued and the descent approach of the LM to challenging landing sites became more complicated, it made more sense to utilize the experiences of a veteran LMP as CDR, as an alternative to promoting an experienced CMP. This suggests that Ed Mitchell, Jim Irwin and Charlie Duke could all have been contenders in Slayton's system to command Apollo 20, 21 and 22. This of course is all conjecture, as events in 1970 changed this planning and the fortunes of several of the 1966 selection.

As the Apollo program progressed through the latter half of 1969, rookie Jack Lousma was, for a while, unofficially targeted for the role of LMP for the Apollo 20 (J5) mission, along with a veteran mission CDR (perhaps Ed Mitchell) and rookie CMP Paul Weitz. However, when the mission was cancelled on 4 January 1970 due to budgetary constraints, the potential crew had not even been officially formed or announced at that time. "It was understood informally," Lousma confirmed when asked, "but was not made official." [3]

Jim Lovell, Ken Mattingly and Fred Haise, the original Apollo 13 crew.

Meanwhile, decisions were being taken to create the infrastructure at the Manned Spacecraft Center (MSC) in Houston to support not only the final, more scientifically-orientated lunar missions, but also the Earth-orbital workshop program that would follow them. On January 28, Science and Applications Director Anthony J. Calio announced three new offices which were added to his Directorate. The new Lunar Missions Office would provide a focus for lunar experiments and investigations during the 'J' series of extended Apollo missions. The 'J' series offered far more sophisticated experiments and equipment with which to study the Moon, both from orbit and on the surface. One of the primary objectives of the AAP workshop, scheduled for launch in 1972, was to study the Earth; therefore, the new Earth Orbital Mission Office would focus on near-Earth scientific investigations. The third new department was the Mission Scientist Office. Here, a scientist astronaut would serve as a representative of the Directorate during mission planning meetings and would be assigned to the mission support team. The first to receive this appointment was Tony England, who was assigned to the role for Apollo 13. [4]

While events in and around MSC focused on the projected termination of Apollo missions to the Moon, the OWS operations began to gather momentum. On February 17, the former AAP was renamed Skylab, taken from a 'laboratory in the sky' suggestion which dated back to 1968, but was held over until after the 1969 presidential election and budget reviews.

Each of the four former MOL astronauts accepted by NASA who were not continuing their education had been assigned to support roles almost as soon as they arrived at MSC the previous September. Given their past experience of Gemini and MOL systems, there was no need for them to endure hours of classroom study and briefings, and they were immediately given technical assignments supporting either Apollo or Skylab and the early studies of the Space Shuttle. Bob Crippen recalled that he did not conduct any 'Apollo' training at all and was assigned immediately to support AAP/Skylab issues, which he thought was quite logical considering his previous work on MOL. Bob Overmyer was also assigned to AAP/Skylab, working on engineering development issues. They were joined on the program by Dick Truly and, for a while, Gordon Fullerton, until he began focusing upon Apollo support duties.

At the start of 1970, there were four confirmed crews (two prime and two backup) in training for Apollo 13 and 14 and two unconfirmed crews (prime and backup) awaiting confirmation for assignment to Apollo 15 (see Table 8).

Table 8 Apollo 13-15 Crewing Assignments circa early 1970. Group 5 astronauts in **Bold** type

Mission	Type	Position	Commander	CM Pilot	LM Pilot
Apollo 13	H-2	Prime	Lovell	**Mattingly**	**Haise**
		Backup	Young	**Swigert**	**Duke**
Apollo 14	H-3	Prime	Shepard	**Roosa**	**Mitchell**
		Backup	Cernan	**Evans**	**Engle**
Apollo 15 crew to be announced	H-4	*Prime*	*Scott*	***Worden***	***Irwin***
		Backup	*Gordon*	***Brand***	*Schmitt*

Expectation

In Deke Slayton's system, it was planned to rotate the backup crews from Apollo 13, 14 and 15 to fly Apollo 16, 17 and 18, formally naming at least one of these crews later in the year. It would also be necessary to announce new backup crews for Apollo 16 and 17, who would then have expected to rotate to Apollo 19 and 20. Instead, with Apollo 20 cancelled, the Apollo 17 backup crew would become a dead-end assignment, probably filled by veteran Apollo astronauts just off a recent flight (as was the case for the last two actual flights, Apollo 16 and 17). The 'original backup crew' for Apollo 16, who may very well have flown on Apollo 19, has been known for several years, though they were never officially confirmed in the latter role (see Table 9).

The crewing for the last three Apollo missions is pure conjecture, as it would have depended upon several factors which did not actually occur, such as the continuation of the program, the availability of hardware, the retention of veteran and introduction of rookie crewmembers, and continued funding. There was also the hope of flying more than one Skylab OWS and providing the crews and launch vehicles for those missions. Several obstacles to these plans emerged, most notably the overriding desire of senior NASA management to end Apollo sooner rather than later and introduce the Shuttle system, the lack of suitable hardware and finance to support the extension of the program beyond Apollo 19 and a single OWS, and a suggestion to fly a solo Apollo docking mission with a Soviet spacecraft.

One of those who missed out thanks to these program cuts was Don Lind. Following his Group 5 selection by NASA, Lind initially trained as an Apollo LMP, including geology training, and was also involved in the development of experimental apparatus for the Orbiting Geophysical Observatory (OGO) satellite. Then came the devastating news that

Table 9 Apollo 16 -19 Crewing circa early 1970. Group 5 astronauts in **Bold** type

Mission	Type	Position	Commander	CM Pilot	LM Pilot
Apollo 16	J-1	Prime	Young	**Swigert**	**Duke**
		Backup	Reassigned to prime crew Apollo 19		
			Haise	***Pogue***	***Carr***
Apollo 17	J-2	Prime	Cernan	**Evans**	**Engle**
		Backup	Original prime crew for Apollo 20		
			Mitchell/Roosa?	***Weitz***	***Lousma***
Apollo 18	J-3	Prime	Gordon	**Brand**	Schmitt
		Backup	Prime Apollo 21 if the program had continued		
Apollo 19	J-4	Prime	Previously backup crew for Apollo 16		
			Haise	***Pogue***	***Carr***
		Backup	Prime for Apollo 22? If flown More likely, members from a previous flight crew – a dead end assignment		
Apollo 20	J-5	Prime	Previously backup crew for Apollo 17		
			Mitchell/Roosa?	***Weitz***	***Lousma***
		Backup	Prime for Apollo 23? If flown More likely, members from a previous flight crew – a dead end assignment		

the last three lunar landing missions were being cut from the Apollo program. The nation had lost its fascination with lunar exploration almost as quickly as it had blossomed after the first landing, and Lind's mission was one of the extended Apollo missions. “There was sadness at our home, because with this announcement, my chance to perform scientific experiments on the Moon was lost. Here was the greatest scientific expedition mounted by man – the exploration of the Moon – and it was conducted by eleven test pilots and only one scientist. I had fully expected to be the second scientist to go up.” [5]

Don Lind told the authors that he fully expected to have been assigned to the backup crew of Apollo 18 and then fly as LMP on Apollo 21, had the program continued. When news came that Apollo 20 had been deleted, it came as a bitter blow not only to Lind, but also to those who had yet to be assigned to a mission, or had some expectation to fly later advanced ‘Apollo’ missions in support of extended lunar studies as part of the AAP. There was also the realization that more flights might be trimmed from the manifest. After four years of training for a mission which might not occur, there was now a strong chance that they may not get to fly in space at all.

Pete Conrad was one veteran astronaut who decided that Skylab would give him a better chance to complete his fourth mission, and he advised his Apollo 12 colleagues Al Bean and Dick Gordon to join him. Bean took his advice and looked to Skylab for his second mission, but Gordon elected to stick it out and try for the command of one of the later Apollo missions. His choice was perhaps made easier knowing that he would be named to the backup crew of Apollo 15 that March. That meant he would later be assigned to command Apollo 18, which for a time looked secure.

On March 26, 1970, NASA named the crews for Apollo 15. [6] The prime crew would be Dave Scott (CDR) and Group 5 astronauts Al Worden (CMP) and Jim Irwin (LMP). This trio had previously been the backups for Apollo 12, so were already a cohesive training unit. As expected, the backup CDR was Dick Gordon, who was teamed with Vance Brand from the fifth group as CMP and 1965 scientist astronaut and geologist Jack Schmitt as LMP. Support crewmembers were named as scientist astronauts Karl Henize, Joe Allen (as Mission Scientist) and Robert Parker.

Apollo 15 was planned at this point to be the fourth and final ‘H’ series mission, featuring a ten-day flight with at least two four-hour periods of surface activity and deployment of the fourth ALSEP payload. The launch was stated to be “6 months after the Apollo 14 mission, presently scheduled for the fall of 1970.” The landing site had yet to be established and would depend upon information returned from orbital imagery taken during Apollo 13 and perhaps 14.

The appointment of Schmitt as backup LMP generated a great deal of media interest. As the first scientist astronaut to be assigned to a flight crew, he was certainly qualified, having helped to train the other astronauts in geology since returning from flight school in 1966. He was also technically senior in the selection hierarchy to the Group 5 astronauts chosen a year later, but as the authors explained in the companion book *NASA's Scientist-Astronauts,* [7] the ‘pecking order’ of the Office at the time was primarily weighted towards the engineering pilot astronauts in order to man-rate the Apollo spacecraft and achieve the first couple of landings, thus proving the system and flight profile worked safely. A shift towards detailed geology and scientific research, aided by flying scientist astronauts on the crew, only came to the fore for later Apollo missions and Skylab. Even then, this was restricted to just one scientist astronaut flying on each resident crew, rather than the two preferred by both the scientific community and some scientist astronauts.

Interestingly, the news releases formally naming the Apollo 15 crew also stated that it was likely that Schmitt "will be a prime crew member on Apollo 17 or 18. Since Dr. Schmitt is the only professional geologist currently qualified for flight crew selection, lunar landing site selection will be an important factor in determining which mission he will fly." Six months prior to the cancellation of Apollo 18, and almost 18 months prior to Schmitt's inclusion on the Apollo 17 mission, there were indications that he would secure a seat on one of the later landing missions at the expense of a pilot astronaut, though at the time it was not clear who that would be.

According to an interview Schmitt conducted with space historian Robert Pearlman in 2012, NASA Headquarters had been insisting on him flying on Apollo 15 at the time Apollo 18 was cancelled. As Pearlman related, "Slayton fought against that because he wanted Schmitt to serve on a backup crew first. Schmitt acknowledges that that was the right thing to do, because serving as backup taught him how to fly Apollo. He wouldn't have been [as] prepared to go if slipped directly into a prime crew. Given Slayton's reasoning, and Schmitt's experience, I think it would be dubious at best that Slayton would have agreed to put another scientist on the prime crew without a prior rotation on a backup crew." [8]

Training for Apollo

Having completed the bulk of their basic and survival training in 1967, the Group 5 astronauts had been occupied with a variety of technical, support and backup assignments and Capcom tours, leading up to – and including – the six Apollo missions flown through December 1969. Now, with the lunar landing goal achieved – twice – and with six crews in training for three planned missions in 1970, the schedule was becoming busy. The missions needed to be better separated, so that previous mission data could be analyzed, subsequent missions could be planned based on that analysis and, ideally, to ensure that the costs of running the Apollo systems were spread across the annual operating budget.

There were five major categories which made up the training of an Apollo flight crew: simulators, special-purpose activities, procedures, briefings and spacecraft tests. [9] The total amount of training by each crew varied, depending upon the time and training hardware available, the mission objectives and previous experience. The CMP mainly, but not exclusively, conducted sessions on the Command Module (CM) simulator, the CM procedure simulator, the dynamic crew procedures simulator, the rendezvous and docking simulator, runs on the centrifuge and related briefings and evaluations by the prime contractor (Rockwell). For the landing crew, consisting of the CDR and LMP, training included less time in the CM simulators but considerably more on the Lunar Module (LM) simulator, as well as contractor briefings with Grumman. For the CDR, there were also several flights on the Lunar Landing Training Vehicle (LLTV; two hours for each flight, plus briefings and simulator time). The landing crew also worked on the LM procedures simulator and associated briefings. For the final three Apollo flights, the training also included simulators replicating the Lunar Roving Vehicle (LRV) and its navigation system. The entire crew participated in the full mission engineering simulator and the transition and docking simulator.

The 'special purpose training' included sessions on lunar science, featuring briefings, focused geological field trips based upon their landing site and studies from orbit, the collection of samples and deployment of experiments, plus training sessions on the LRV trainer for the final landing crews. On top of all of this were sessions in the Water Immersion Facility – on the surface for evacuation of the CM after splashdown, and underwater for zero-g simulations such as transfer between CSM and LM – as well as stowage training for the CM and LM; checkouts using the EVA and IVA suits; bench checks of government-furnished equipment, experiments and other associated hardware, medical equipment and techniques; visits to the planetarium for celestial navigation training; and fire and fire suppression training. For Apollo 15 through 17, the CMP also had to conduct EVA training, both underwater and in the KC-135 aircraft flying parabolas, for the trans-Earth EVAs to collect the film cassettes from the SIM-Bay in one sector of the Service Module (SM). Then there was additional training at the Cape, for nominal vehicle ingress and egress on the pad, and emergency egress procedures in both simulators for launch abort scenarios and actual hardware to practice crew escape techniques. If this was not enough, there were also scheduled press conferences, meetings with the principle investigators and suppliers of specialized equipment, and public outreach events.

For simulations of lunar surface activities, the training was broken down into sessions replicating actual planned surface operations, the operations required to prepare for EVA before leaving the LM, and the post-EVA activities back inside the LM. The totals for missions involving Group 5 astronauts (as flown), can be found in Table 10.

In addition, each crew had to complete a program of geological field trips of increasing complexity, especially for the 'J' series of missions. The trips were organized to locations on Earth which included features analogous to those at the intended landing sites. A series of field exercises then followed these geological sampling trips, to simulate the lunar traverse and use some of the sampling techniques and equipment the astronauts would use on the mission. Initially unsuited, or partially suited, these simulations were eventually conducted in full training suit regalia and in direct communication with the science support teams in Mission Control in Houston, working with the surface crew on location as they

Table 10 APOLLO LUNAR SURFACE ACTIVITY SIMULATIONS (number of training sessions)

Mission	Type	Surface Operations	Operations before and after EVA activities	Total per mission	Group 5 astronauts involved in prime or BUp positions*
Apollo 11	G	20	10	30	*Haise (BUp)*
Apollo 12	H-1	31	4	35	*Irwin (BUp)*
Apollo 13	H-2	42	11	53	Haise/*Duke (BUp)*
Apollo 14	H-3	43	18	61	Mitchell/*Engle (BUp)*
Apollo 15	J-1	91	20	111	Irwin
Apollo 16	J-2	67	10	77	Duke/*Haise (BUp)/ Mitchell (BUp)*
Apollo 17	J-3	47	20	67	*Duke (BUp)*
Total 7 missions		341	93	434	

*Assignments are representative only. Specific session participations are not detailed in this table for prime and/or backup positions

[Data courtesy: Apollo Summary Report, NASA LBJ Space Center, Houston Texas, April 1975, JSC-09423 Section 6.2 Flight Crew Training Program] would on the actual mission. Geological field trips for the seven planned landing missions lasted for between one and seven days. There was one trip for Apollo 11, four trips for Apollo 12, and seven each for the Apollo 13 and Apollo 14 crews. The Apollo 15 crew conducted 12 trips, and there were 18 trips for Apollo 16 and 13 trips for the final mission, Apollo 17.

With the training almost complete, each prime crew was then required to conduct a full mission dress rehearsal of the different flight phases. These were designed to integrate the crew and the ground support personnel and incorporated elements of the mission flight plan. The number of days completed by each *prime* crew in these simulations is reproduced in Table 11, recording only those which included a crew member from the fifth astronaut selection group (i.e. from Apollo 13 through Apollo 17).

Apollo 13 (April 11-17, 1970)

Flight crew: James A. Lovell, Jr., (CDR), John L. SWIGERT, Jr., (CMP), Fred W. HAISE, Jr., (LMP)
Backup crew: John W. Young (CDR), Thomas K. MATTINGLY II (CMP), Charles M. DUKE, Jr. (LMP)
Support crew: Vance D. BRAND, William R. POGUE, Jack R. LOUSMA
Objective: 7th manned Apollo flight; intended 3rd manned lunar landing mission (H-2)
Spacecraft: Odyssey (CSM-109); LM Aquarius (LM-7)
Launch Vehicle: Saturn V (AS-508)
Duration: 5 days 22 hours 54 minutes 41 seconds.
Capcoms: (Group 5) BRAND (Maroon team), DUKE (Gold Team), LOUSMA (White team)

On April 13, at GET 55 hrs 55 mins 20 secs into the mission, the No. 2 oxygen tank in the SM exploded when commanded to 'stir' the cryogen inside. A heater switch had welded together and the fault remained undetected during a pre-launch test months before. The explosion, 222,461 miles (328,000 km) from Earth, forced the lunar landing to be aborted. The descent engine of the still-attached LM was used for course corrections in a daring plan to get the three astronauts safely home. The combined efforts of the crew and ground controllers, contractors and support staff pulled it off. The descent engine was used

Table 11 APOLLO INTEGRATED PRIME CREW/GROUND MISSION SIMULATIONS

Mission	Type	CM simulator	LM simulator	CM & LM simulators	Total per mission
Apollo 13	H-2	13	5	9	27
Apollo 14	H-3	12	5	12	29
Apollo 15	J-1	13	5	7	25
Apollo 16	J-2	16	7	10	33
Apollo 17	J-3	13	6	9	28
Total 5 missions		67	28	47	142

Includes participation by Mission Control personnel
[Data courtesy: Apollo Summary Report, NASA LBJ Space Center, Houston Texas, April 1975, JSC-09423 Section 6.2 Flight Crew Training Program]

[Inset] Haise, asleep in LM *Aquarius*, and [main picture] Swigert during the Apollo 13 mission.

successfully three times; first to place the combined spacecraft back on a lunar looping trajectory to guarantee a rendezvous with Earth four days later, then to speed up the return leg, and finally to refine the trajectory. [10]

The recovery attempt succeeded, with the CM splashing down in the Pacific Ocean on April 17. The events over those six days have been described as 'NASA's Finest Hours,' while the mission was termed a 'successful failure,' as it succeeded in returning the three astronauts safely to Earth but failed in its primary objective of landing a third crew on the Moon. Following the loss of Apollo 20 and restrictions to the NASA budget by the administration of the new president (Richard M. Nixon), this latest setback clearly influenced the review of future Apollo plans later in in the year. Fearful of losing a crew in deep space, or stranded on or around the Moon with no hope of rescue, NASA management introduced a plan to wind up the program by terminating two more landings and flying just four more missions, leading to the last Apollo lunar flight being completed by the end of 1972.

On Apollo 13, Group 5 astronauts Fred Haise and Jack Swigert, the first of their selection to fly in space, also became the 13th and 14th astronauts to make the three-day flight to the Moon, though unfortunately they could not enter orbit. Perhaps one of the most famous missions in NASA history, the story of Apollo 13 was subsequently told in the 1994 *book* Lost Moon *by Jim Lovell and Jeffrey Kluger and the following year was made into a highly successful feature film, starring Tom Hanks as Lovell with Kevin Bacon as Swigert, Bill Paxton as Haise, and Gary Sinise as Ken Mattingly.*

Lousma at Capcom console during Apollo 13, with Vance Brand (leaning over his shoulder), Mattingly (behind Brand), Deke Slayton (left) and John Young (right, with pipe).

Organizing the Skylab Branch Office in the Astronaut Office

The focus for both NASA and the Astronaut Office following Apollo 13 was to examine the cause of the accident and provide recommendations about preventing a similar incident on future missions. While debate over the number of landings continued, there was also a growing interest in the Skylab program, and while no crews had been formally assigned, there was an effort to organize the Skylab Branch Office within the Astronaut Office. A memo from Deke Slayton, on May 27, included an organizational chart explaining the functional responsibilities and administrative organization for the program that had been established in the Astronaut Office. [11] The Chief of the Skylab Flight (Branch) was now Pete Conrad, with the Branch divided into three Sections.

Section A (headed by Walt Cunnigham): This section included the Earth Resources Group (LIND and Lenoir), the Medical Operations Group (Kerwin, Holmquest, Thornton and Musgrave), and the Scientific Experiments Group (McCANDLESS, Allen, Chapman, Parker, England and Henize).

Section B (Al Bean): This was the Hardware Group and featured all seven former MOL astronauts (BOBKO, CRIPPEN, FULLERTON, HARTSFIELD, PETERSON, OVERMYER AND TRULY).

Section C (Rusty Schweickart): This was the EVA/IVA Group and included Owen Garriott and Ed Gibson.

Slayton's chart also listed Bobko, Hartsfield and Peterson as "attending school," while all members of the Scientific Experiments Group and Fullerton from the Hardware Group were listed as "on loan to Mainline." This of course meant the main Apollo program, but it is interesting that they were identified as being on loan *from* AAP and *to* the lunar missions, meaning that they were not considered part of the Apollo training group.

A second chart expanded the technical assignments further. Along with Walt Cunnigham and Al Bean, Pete Conrad was responsible for the operations, training and flight planning for the Branch.

Section A was then divided into four groups: CSM (Cunningham, Kerwin and Allen); Corollary Experiments (McCANDLESS, CRIPPEN, TRULY, Allen, Henize, Chapman and Gibson); Medical Operations (Kerwin, Musgrave, Holmquest and Thornton); and Earth Resources Experiments (LIND and Lenoir).

Section B had three divisions: OWS (TRULY and Henize); AM/MDA (OVERMYER and Lenoir); and ATM (Garriott and CRIPPEN).

Section C also had three divisions: EVA (Ed Gibson), Suits (Schweickart) and IVA (Kerwin).

Several astronauts took on technical roles in more than one area, quite often because there were far more roles to fill than astronauts to fill them, especially as many of them were involved with the mainline Apollo program. What is interesting is that the Skylab training group did not yet include four of the astronauts who would eventually fly on the three missions (Jerry CARR, Jack LOUSMA, Bill POGUE and PJ WEITZ), because at the time the chart was created they were still hoping for an Apollo flight to the Moon.

THE LOST OPPORTUNITIES

While the review into the Apollo 13 accident progressed, preparations for the remaining missions continued. Due to the importance of the Fra Mauro region of the Moon to lunar scientists, Apollo 14 was subsequently re-targeted to the landing site of Apollo 13, but all other missions and sites remained under review. There was a growing consensus to move from the limited 'H' series missions straight to the 'J' series of 'super-science' missions, to gain the maximum return from each of the remaining flights before the program ended. In the immediate aftermath of Apollo 13, there remained two 'H' series (Apollo 14 and 15) and four 'J' series missions (Apollo 16 to 19) on the manifest. With crews in training, or in line to fly them (though not all had been officially named), each featured significant representation from the Class of 1966.

The Shepard-Roosa-Mitchell crew and the Scott-Worden-Irwin crew were training for Apollo 14 and 15 respectively. Their backups were expected to fly on Apollo 17 (Cernan-Evans-Engle) and 18 (Gordon-Brand-Schmitt). Another pair of 'crews' had been brought together for preliminary training but were yet to be officially named. They were the former backup crew of Apollo 13 (Young-Mattingly-Duke), in line to fly Apollo 16, and a new backup team identified as Fred Haise (CDR), Bill Pogue (CMP) and Jerry Carr (LMP). For nearly six months during the spring and summer of 1970, this second trio expected to rotate to Apollo 19, now the final mission to the Moon. Although no official confirmation came of their assignment, it is acknowledged that these were the crewmembers and there is evidence to support this.

In his NASA Oral History interview, Mattingly stated that following Apollo 13, Deke Slayton offered him two options. Either he could serve as CMP on Apollo 16, as the position had been vacated by Jack Swigert who had replaced him on Apollo 13, or he could become the backup LMP for the same mission and then rotate as prime LMP for Apollo 19. Slayton told him the smart move would be to take the Apollo 16 flight position, as there was little certainty of many missions after that. This meant he would not get to walk on the Moon, but he would at least have a greater chance of orbiting it. Mattingly wisely accepted the offer of the vacant CMP seat on Apollo 16 crew.

The July 31, 1970 edition of MSC *Roundup* [**12**] mentions a group of 14 astronauts witnessing, from 10,000 feet away, the creation of a man-made crater at the Canadian Defense Research Establishment near Suffield, Alberta, Canada. At this remote test site on July 23, 1970, 500 tons of TNT was detonated as part of an international test. The resulting crater measured 230 feet in diameter and 15 feet deep, leaving a central uplift peak that replicated several formations found on the Moon. After the test, the astronaut group viewed the crater close up, examining both its interior and the surrounding ejecta. The Apollo 15 prime and backup crews were in attendance, together with John Young and Charlie Duke from the yet to be named prime crew for Apollo 16, and scientist astronauts Robert Parker, Tony England and Joe Allen who were preparing for support and Mission Scientist roles. The remaining three members of this group were identified as Fred Haise, Bill Pogue and Jerry Carr, who attended in their role as potential backup crew members for Apollo 16 and in preparation for their expected flight on Apollo 19.

The three astronauts had conducted some preliminary work in support of Apollo 16 before the official crewing announcement, including developing the mission and training plans, but according to Jerry Carr there was only minimal discussion about the possibility of Apollo 19. Haise had checked out in the LLTV in his role as backup CDR and the 'crew' completed some limited simulator work, but only when the Apollo 14 and 15 crews were not in attendance. In the late 1990s, Haise revealed in correspondence with the authors that the three of them had also completed some geological field exercises with the Apollo 16 crew. In addition, Jerry Carr, together with Jack Lousma, had been instrumental in providing Astronaut Office technical support during the development tests of the Boeing LRV, and all three had extensive experience in supporting early Apollo missions, making them a strong possibility for crewing Apollo 19. If this crew had flown as planned, they would have been the first and probably *only* flight crew to have been solely made up of Group 5 astronauts.

Sadly, nothing came of it. As early as June, reports in the publication *Aviation Week* suggested that NASA was conducting internal discussions about using more of the hardware assigned to future landing missions to support a launch of the backup OWS as Skylab B in 1975, and perhaps a third six-man Skylab C in 1976. In reality, it would have been a stretch to ensure there would be sufficient hardware to warrant three Skylab workshops from what was left and available for flight. In August, MSC *Roundup* [**13**] reported that alternative plans for Apollo were being evaluated, with a commitment to fly most of the remaining hardware before the program was terminated; though whether it was all intended for the Moon was questionable. One plan was to fly the six remaining Apollo missions, with the launch of Apollo 14 in January 1971 and then, at six month intervals, Apollo 15, 16 and 17. They would be followed by Skylab A, comprising the unmanned workshop and three resident crews flying from late 1972 and into 1973, with Apollo 18 and 19 returning to the Moon for the final landings in 1974. Another option was to fly Apollo 19 as a lunar-orbital mission only, but it was a third option that was finally taken.

On September 2, NASA Administrator Thomas O. Paine announced the decision to cut two more Apollo flights, which were the final 'H' mission, Apollo 15, and the last 'J' mission, Apollo 19. Following Apollo 14, the remaining three Apollo missions would all be 'J' series, re-designated Apollo 15 through 17. Budget restrictions were cited in the decision, together with the desire to develop the Space Shuttle, "followed by a space station," which meant a much larger permanent facility than Skylab offered. [**14**] Haise, Pogue and Carr were on a field geology trip at the Colorado Plateau in northern Arizona, along with prime Apollo 16 crewmembers John Young and Charlie Duke, when official word of the cancellation of Apollo 19 came through. It was devastating news, and with it their hopes of flying to the Moon were instantly dashed. "So, I was hoping John Young might break his leg late in the game and I'd get to go," Haise joked to an audience many years later, "but it didn't happen." [**15**]

Unfortunately for the astronauts, there were now too few missions for too many candidates, and a lot would miss out. The scientific community was also up in arms. Why appoint a group of scientist-astronauts, as NASA had done back in 1965, when the opportunity for any of them to fly to the Moon was extremely remote?

Three lunar scientists expressed their concern about the cancellation of Apollo 15 and 19 in a September 1970 article in the *New York Times*. Dr. Thomas Gold from Cornell University said, "It's like buying a Rolls Royce and then not using it because you claim you can't afford the gas." Nobel Prize winner Dr. Harold Urey declared, "I think the American people and Congress should realize that the Moon is an extremely old object ... this gives scientists a way of studying an object that goes back to the very beginning of the solar system." He added that the saving of 40 million dollars in cancelling the two flights was "chicken feed," in light of the 25 billion already spent on the Apollo program. Finally, former scientist astronaut Dr. Brian O'Leary weighed in with; "The scientific community has become disenchanted with NASA. The present decision seems ridiculous."

The *New York Times* then offered its own solution to the situation: "Throughout the last decade, this newspaper opposed the top priority then accorded Project Apollo on the grounds that too much money was being diverted from urgent social needs. But now that these huge sums have been spent, the need is to obtain the maximum yield, scientifically and otherwise, from that investment. Surely NASA, which has been able to reach the Moon, can find a better solution than the one now afforded for adjusting to austerity in space research. One desirable alternative would be to enlist foreign resources in the exploitation of Apollo technology, perhaps by offering to send teams of British, French or Soviet astronauts on the journey pioneered by Apollo 11."

Al Shepard's Apollo 14 crew was secure in the knowledge that their mission preparations and training were far enough advanced to fly their mission early in 1971. However, while the Apollo 15 crew also still expected to fly their mission, it would now be a more advanced 'J' mission involving more content than originally planned. While there was time to adjust the training schedule, there remained doubt as to how far the cuts and changes might affect their flight. Both Jim Irwin and Al Worden wrote that the changes were not a major concern and that with several months available to revise their training schedule from 'H' to 'J' category, it was not a big deal.

What *was* becoming a talking point was whether backup LMP, geologist Jack Schmitt, would fly at all, now that the flight that was to take him to the Moon had been cut. There was growing pressure from the scientific community to replace one of the pilot astronauts in line for the 'J' missions with Schmitt. Jim Irwin wrote that there was indeed some pressure to replace him on Apollo 15 but, with the support of both Slayton and Shepard, his CDR Dave Scott rejected that idea outright. [**16**] While other crews for the remaining two missions had yet to be announced officially, the team of Haise-Pogue-Carr would not now be going to the Moon and were split up before being formally identified as a 'crew.'

A training group for Skylab

Towards the end of the year, there were significant changes within the Astronaut Office. An updated organizational chart of the Office, dated August 1970, listed Apollo 13 astronaut Jack Swigert under the Advanced Programs Flight (Branch), which was headed by Jim Lovell and also included Buzz Aldrin. That branch monitored early developments with the Space Shuttle program, among others. The Skylab training group had been formed that same month, for the fifteen places on the three prime and backup crews planned for the first workshop. There remained possibilities for a fourth and even a fifth manned visit to the workshop, depending upon how it stood up to prolonged orbital flight and whether funding was available[1]. In addition, a support team was required to help with the added scientific complexity of the manned missions. The astronauts might not be going to the Moon for two weeks, and there were only three planned missions, but each would last much longer; originally for 28, 56 and 56 days. Each crew would be conducting an extensive scientific program of Earth resources, astronomy, medical and technological investigations, as well as learning to live and work in space for an extended period. There would be no resupply craft or visiting missions, with the crews leaving the station unoccupied in between their residencies. Skylab offered a unique opportunity to all who flew to it, including four Group 5 astronauts. It was certainly going to be a challenge for each of them, and very different to what had gone before. The original idea for crewing was to assign only two backup crews to the three missions, with the second and third missions using the same backups. They could then fly either the fourth and fifth missions if called upon, or the first two residences to the planned Skylab B.

---

[1] In the event, only the three manned missions flew to the workshop as originally planned, though there was some discussion prior to the third mission of flying a short 21-day closeout mission as Skylab-5. Instead, the third mission was increased from 56 to 84 days.

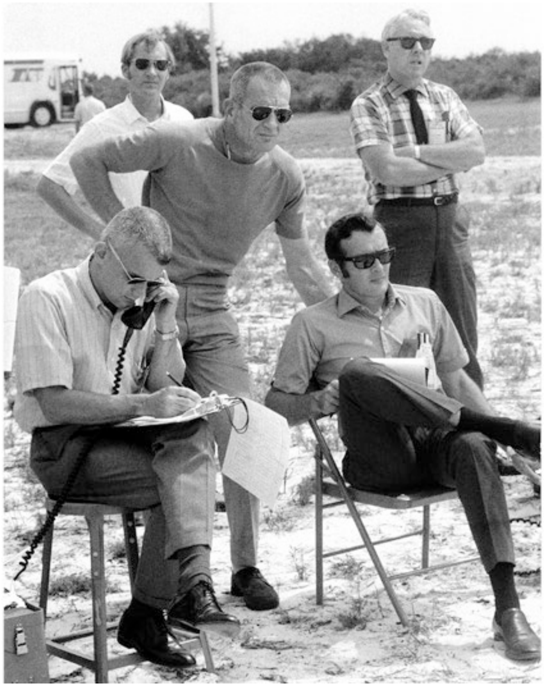
Astronaut Office involvement in AAP and then Skylab had been the remit of veteran astronauts and Group 4 scientist astronauts for over five years. They were joined by members of the fifth group from late 1966, supplemented by the next intake of scientist astronauts once they had completed their training in 1969, and subsequently expanded by some of those who transferred from MOL later that year.

In September 1970, Dick Truly led a group of nine (unidentified) astronauts to the Marshall Space Flight Center (MSFC) in Huntsville, Alabama, for a one-week evaluation of the proposed Skylab crew station being developed there. Following the cancellation of the three Apollo missions, several of those who were in line to fly those final lunar missions were moved across to Skylab to begin preliminary mission training in October of that year, including Carr, Lousma, Pogue and Weitz. Pete Conrad now headed the Skylab training group, having replaced Walt Cunningham who had been in charge since returning from Apollo 7. The group also included veteran pilot astronauts Rusty Schweickart and Al Bean, Group 5 astronauts Bruce McCandless and Don Lind, and scientist astronauts Owen Garriott, Ed Gibson and Joe Kerwin from the 1965 group, and Story Musgrave, Bill Lenoir, Bill Thornton and Donald Holmquest from the 1967 group. The Skylab crews would be formed from this group of astronauts. From the recently arrived seventh group, Dick Truly, Bob Crippen and Bob Overmyer were already performing engineering support roles, prior to the formal naming of a support crew, Capcoms and the Mission Scientist.

As the year closed, former MOL astronaut Gordon Fullerton was assigned to the support crew of Apollo 14, replacing Bill Pogue who had been assigned to the Skylab training group following the cancellation of Apollo 19. Around the same time, Deke Slayton had informed Stu Roosa that he wanted him to perform the backup CMP role on Apollo 16 after completing his Apollo 14 duties. This was of course a dead-end role, with no Apollo 19 to rotate to. It also underlined Slayton's confidence in Roosa's ability, giving further evidence to his consideration for the command of a later mission had the opportunity arisen.

APOLLO'S PENULTIMATE YEAR

The year 1971 opened with the news that while a significant amount of work at MSC was still directed to the lunar program, particularly Apollo 14, a group of astronauts and potential Skylab crewmembers had been undergoing specialized training since October 1970 as solar observers and were undertaking a special course in solar physics. For the scientist members of the group, this was an extension of their existing academic skills, but for the former jet pilots it was a whole new topic, having spent years being taught how to fly to the Moon and master geology. This new training was designed to prepare each crewmember for operating the Apollo Telescope Mount (ATM), an external structure on Skylab containing a suite of solar telescopes and an Earth resources package and an Earth resources package that supported two of the primary objectives of the Skylab program. [17]



Supervised by Deke Slayton, Bruce McCandless (seated left) participates in EVA Capcom training, 1970. (Courtesy Ed Hengeveld)

Apollo 14 (January 31 – February 9, 1971)

Flight crew: Alan B. Shepard, Jr., (CDR), Stuart A. ROOSA (CMP), Edgar D. MITCHELL (LMP)
Backup crew: Eugene A. Cernan (CDR), Ronald E. EVANS (CMP), Joe H. ENGLE (LMP)
Support Crew: William R. POGUE, Bruce McCANDLESS II, Charles G. FULLERTON
Spacecraft: Kitty Hawk (CSM-110), Antares (LM-8)
Launch Vehicle: Saturn V (AS-509)
Objective: 8th manned Apollo mission; 3rd manned lunar landing (H-3)
Duration: 9 days 0 hours 1 minute 57 seconds
Capcoms: (Group 5/7 only): EVANS, HAISE (Gold team), MCCANDLESS (Maroon Team), FULLERTON (Orange team).

Capcom assignments for Apollo 14 were listed in a memo dated October 19, 1970. [18] The memo also stated that Ron Evans had been assigned as a CSM Capcom during simultaneous but unrelated CSM/LM activities, and for a single shift after the TEI burn. Fred Haise had also volunteered to support Capcom activities during the mission to take advantage of the training he had been given for Apollo 13, especially during the surface activities at Fra Mauro, utilizing his geological training for the second EVA, now reassigned to Apollo 14.

Originally targeted to land at the Taurus-Littrow region of the Moon, Antares*, the LM of Apollo 14, landed Shepard and Mitchell at the Fra Mauro site assigned to the aborted Apollo 13 mission. At the start of the mission, there was a fear that yet another lunar landing would have to be aborted. This time, it was because it had taken six attempts to dock with the unmanned LM to retrieve it from the top of the third stage of the Saturn launch vehicle. CMP Roosa finally hard docked with the lander to extract it. A later inspection of the docking system did not reveal any problems, allowing the landing to proceed and adding weight to the suggestion that a buildup of ice had caused the difficulty. Two EVAs (Feb 5, 4 hrs 49 mins; Feb 6, 4 hrs 35 mins; total 9 hrs 24 mins) were accomplished during a surface stay time of 33 hrs 39 mins. In addition to the deployment of the second full ALSEP, the crew conducted foot-traverses aided by the Mobile Equipment Transporter (MET), though at times the astronauts were forced to carry the cart when it became bogged down in lunar surface material. The undulating terrain confused the astronauts in their search for the rim of Cone Crater, but later analysis indicated that they had (unbeknown to them at the time) almost reached it. These difficulties emphasized the need for a more rugged mode of surface transport with an accurate navigation system. Fortunately, the LRV was scheduled for Apollo 15 – now the first of the 'J' missions. During his 34 lunar orbits (66 hrs 39 mins), Stu Roosa conducted extensive observations from the CSM, photographing future landing sites and adding to the knowledge of the lunar surface far beyond the landing site.*

Apollo 16 crew named

NASA finally announced the crew to fly the penultimate Apollo lunar mission on March 3, 1971. [19] As expected, three-time space veteran John Young would be in command, accompanied by CMP Ken Mattingly and LMP Charlie Duke. Young and Duke were expected to make the fifth landing on the Moon in the spring of 1972. With the cancellation of the three Apollo missions the previous year, assignment to the backup crew was now a redundant position, with no rotation to a later flight. As a result, the positions were filled by veterans from the previous two missions. Fred Haise (CDR) was now joined by CMP Stu Roosa and LMP Ed Mitchell, instead of Pogue and Carr who had been reassigned to Skylab. Apollo 16 was to be the second 'J' series flight, lasting about 12 days and including a surface stay time of about 67 hours, with 20 hours of surface EVA activities. The support crew was not named at the time, but was subsequently identified as scientist astronaut Tony England (also Mission Scientist) and Group 7 astronauts Hank Hartsfield and Don Peterson, both of whom had recently arrived at MSC, along with Karol Bobko, after completing their educational courses following the cancellation of MOL.

Apollo 15 (July 26 – August 7, 1971)

Flight crew: David R. Scott (CDR), Alfred M. WORDEN (CMP), James B. IRWIN (LMP)
Backup crew: Richard F. Gordon (CDR), Vance D. BRAND (CMP), Harrison H. Schmitt (LMP)
Support crew: Karl G. Henize, Robert A.R. Parker, Joseph P. Allen IV
Spacecraft: Endeavour (CSM-112), Falcon (LM-10), LRV-1

Launch Vehicle: Saturn V (AS-510)
Objective: 9th Apollo manned mission; 4th manned lunar landing (J-1)
Duration: 12 days 7 hours 11 minutes 53 seconds
Capcoms: (Group 5/7 only) FULLERTON, MITCHELL, BRAND

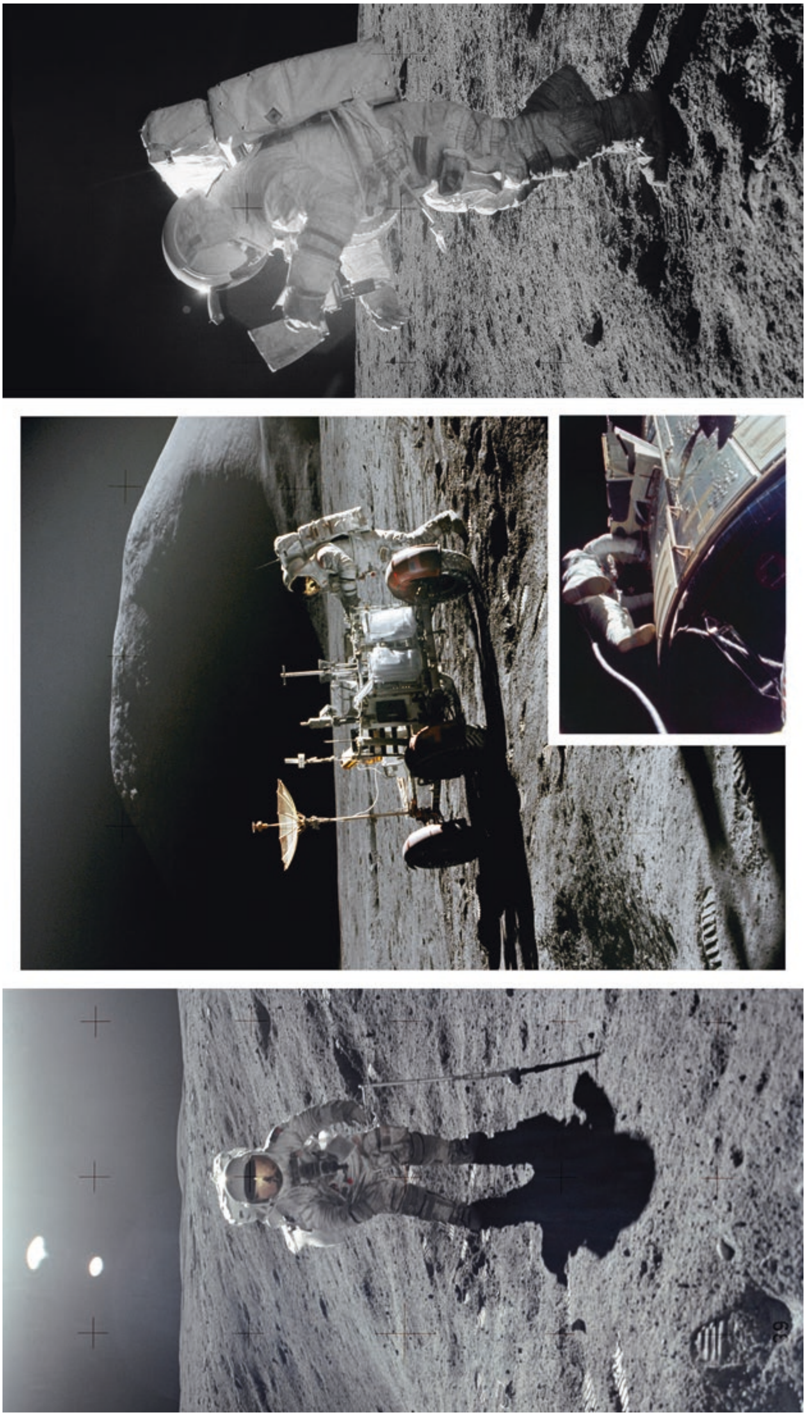
The first of the super-science 'J' missions, Apollo 15 was targeted for the Hadley Apennine area near the Hadley Rille. With improved cameras and equipment, this was a visually spectacular mission in addition to being a rewardingly beneficial scientific one. Falcon *landed on the surface on July 30 for a stay time of 66 hrs 55 mins. Two hours after touchdown, in the early hours of the following day, Scott performed a unique 27 min standup EVA, standing on the ascent engine cover and sticking his head out of the upper docking port of the LM to describe the scene around the lander. Scott and Irwin conducted three surface EVAs, utilizing the LRV to traverse a total of 17 miles (27 km) across the lunar terrain and greatly expanding the capabilities for geological exploration. The three surface EVAs totaled 18 hrs 35 mins (Jul 31, 6 hrs 33 mins; Aug 1, 7 hrs 12 mins; Aug 2, 4 hrs 50 mins). While Scott and Irwin were on the lunar surface, Worden operated and monitored the suite of experiments in the Scientific Instrument Bay of the SM and conducted further landmark sightings and photography.* Endeavour *remained in orbit for 74 orbits (6 days 1 hr 18 mins) before firing its main engine to begin the return flight to Earth. During the trip back to Earth on August 5, Worden completed the first 'deep space' (or trans-Earth) EVA, assisted by Irwin from the open CM hatch, spending 34 minutes retrieving experiments, samples and film cassettes from the SIM Bay.*

All change on the 'Last Apollo'

On August 13, 1971, NASA announced that scientist astronaut and geologist Jack Schmitt would replace LMP Joe Engle on the last Apollo mission to the Moon. [20]. The crew was therefore confirmed as Gene Cernan (CDR), Ron Evans (CMP) and Schmitt (LMP). The recently returned Apollo 15 crew of Scott, Worden and Irwin were named as backups, filling the second dead-end assignment and taking advantage of their previous training and experience. By this point, Al Worden had already indicated that he would leave NASA following his Apollo 17 duties. Meanwhile, it was reported that former Apollo 17 LMP Joe Engle had been reassigned to the Space Shuttle Branch Office of the Astronaut Office, working on early development tasks.

When asked at the time about losing his place on Apollo 17, Joe Engle told Jim Maloney from the *Houston Post* that, "when something like this happens, you can do one of two things. You can lay on the bed and cry about it ... or you can get behind the mission and make it the best in the world." [21] Thirty years later in 2001, as he was inducted into the Astronaut Hall of Fame, Engle told reporters that, "When you think about it, the lunar missions were geology-oriented. Jack Schmitt had a degree in field geology, and I couldn't argue with that. I certainly wanted to go to the Moon real bad." [22] He also admitted that the hardest thing he had to cope with at the time was telling his children he wasn't going to the Moon.

At the time, the Space Shuttle remained the desired, if unauthorized program, but looked highly likely to succeed the Apollo-era spacecraft. As a result, a number of astronauts began to take early Shuttle development assignments. One of these was at Lockheed, who had set up a simulator to replicate the expected flying characteristics of the Shuttle



Stepping back in time. The Group 5 Moonwalkers (L to R): LM Pilots Charlie Duke (Apollo 16), Jim Irwin (Apollo 15) and Ed Mitchell (Apollo) 14, with [Inset] Apollo 15 CMP Al Worden, the first person to perform a deep-space EVA.

orbiter. This was being evaluated by several astronauts, including Jack Swigert, Gordo Fullerton, Hank Hartsfield and Don Peterson, as well as NASA research pilots John A. Manke and William H. ('Bill') Dana.

For the NASA Oral History program, Joe Engle recalled being involved in the selection of manufacturers in the conceptual design of the Shuttle. "I do remember Rockwell and McDonnell Douglas [Corporation] and Grumman were three of the primary competitors initially and had different design concepts for the Shuttle; all pretty much the same, but they were significantly different in shape and in configuration for launch, using different types of boosters and things. I was part of that selection process as an engineer and a pilot, assessing a very small part of the data that went into the final selection. But it was interesting. It was very, very interesting, and it, fortunately, allowed me to pull on some of the experience that I had gotten at Edwards in flight testing, in trying to assess what might be the most reasonable approach to either flying initial flights, data-gathering, and things of that nature." [23]

A WANING MOON

Just four days into 1972, NASA announced that Apollo 16 LMP Charlie Duke had been admitted to Patrick AFB Hospital, Florida, for "treatment for bacterial pneumonia." [24] The astronaut was not seriously ill, merely suffering from a very bad cough and cold, but in light of the pending lunar mission, he had been advised to seek medical attention. Fortunately, his condition was not expected to have a serious impact on the flight, or his training for it, but it was expected that he would need two weeks for full recovery.

Skylab Crews Named

Two weeks later, on January 19, 1972, NASA finally released the crewing details for the three Skylab missions planned for an eight-month period in 1973. [25] There had been much speculation over who would take the nine flight seats, with each crew comprising a Commander (CDR), a Pilot (PLT formerly CMP) and a Science Pilot (ScPlt). The prime crews were announced in a memo from Deke Slayton on March 4, 1971, as:

- First mission, planned for 28 days: Charles Conrad (CDR), Paul Weitz (PLT) and Dr. Joe Kerwin (ScPlt)
- Second mission, expected to last for 56 days: Alan Bean (CDR), Jack Lousma (PLT), Dr. Owen Garriott (ScPlt)
- Third mission, also a 56-day duration: Gerald Carr (CDR), William Pogue (PLT) and Dr. Edward Gibson (ScPlt).

Only Conrad and Bean had flown in space before. The remaining seven astronauts would be making their first foray into Earth orbit and it was also noted that the crew for the third mission was the first all-rookie crew since Gemini 8 in March 1966. Carr also became the first CDR since Jim McDivitt on Gemini 4 in 1965 who had not previously served on a backup crew.

The announcement also included the two backup crews for the three missions. For the first mission, Russell Schweickart (CDR), Bruce McCandless (PLT) and Dr. Story Musgrave (ScPlt) were named, with Vance Brand (CDR), Dr. Don Lind (PLT) and Dr. William Lenoir (ScPlt) named for both the second and third missions. An explanation of why two and not three backup crews were chosen was put forward by Tom Stafford, in discussions with Michael Cassutt in 2001. With the passage of time the details had become a little vague, but in 1971 there was a firm requirement for a physician backup on the first mission, so Musgrave backed up Kerwin as part of a specific team for the first mission. However, the second and third missions were designed to build on each other, so the teams which backed up the second crew could easily slip into the same role for the final mission. There was never a discussion of just one backup crew for all three missions; it was either two or three backup crews. [26] Finally, a six-person support crew was assigned for all three Skylab missions, comprising Bob Crippen, Hank Hartsfield, Dick Truly, Bob Parker (Mission Scientist), Karl Henize and Bill Thornton.

In Mission Control during Apollo 16, physician Dr. John F. Zieglschmid (left) discusses the flight with Charlie Duke's twin brother William and their father, Charles M. Duke, Sr.

For the first time, a rescue capability existed for the Skylab missions, made possible by preparing the next spacecraft and launch vehicle in the series as a potential rescue vehicle, should the crew on orbit become stranded. For the third mission, the vehicle being prepared for ASTP would act as the standby rescue vehicle. Had a rescue flight been required, then Vance Brand and Don Lind were trained to perform a two-man rescue flight and return the three stranded astronauts inside the one, very crowded, CSM.

Two of the Group 5 astronauts named to backup crews were also co-investigators on Skylab experiments. Bruce McCandless had worked for some time on the development of the M-509 Astronaut Maneuvering Unit experiment which was to be tested inside the orbital workshop, evaluating its potential as a future EVA maneuvering aid. In addition, physicist Don Lind was a co-investigator on S-230, the ATM Magnetosphere Particle Composition Experiment.

Training for Skylab

From their assignment to the program until their flights, the emphasis of the crews' training was on experiments, systems management, and habitability. In reality, 'training' for Skylab had begun in earnest in 1970, though many scientist astronauts and some of the Group 5 astronauts had been involved in AAP OWS development issues since arriving at NASA in the mid-1960s. On average, each three-person Skylab team spent about 450 hours at briefings and attending reviews, with about 96 hours spent on systems tests and training and a further 156 hours of EVA training. The actual 'mission' training varied, because of the duration of each mission and its planned content, but grew to 108 hours for the first crew, 127 hours for the second and 119 hours for the final crew. Each crew also logged an average of 700 hours on various simulators and spent a total of 98 hours on medical training in case of injury or emergency. The first crew spent just 8 hours on rescue training, while the second crew doubled that with 16 hours and the third accumulated 24 hours.

For the experiments, the first and second crews completed about 134 hours of medical experiment training, while the third crew logged just 98 hours. Training on the Earth Resources Experiment Package (EREP) took 72 hours, the ATM courses added another 46 hours and corollary studies reached 178 hours for the first crew, 209 for the second and 165 hours for the third. With greater emphasis on science over engineering or operations, Skylab was a significant change to what most of the astronauts had focused upon since joining NASA. For Apollo, the training to deploy ALSEP and the study of geology to select and collect lunar samples, or CSM observations from orbit, was all for just a brief period of an 8- to 12-day mission. Skylab's more involved program of training involved disciplines that would be put to use over several weeks, and trying to master it all proved challenging. Former Marine pilot Jerry Carr, who had trained to land on the Moon and collect rocks and would now command the longest mission in Earth orbit to date, confessed that he became a much better solar observer once he stopped trying to become a solar scientist.

In addition to the research program, Skylab would still require a program of engineering tasks, housekeeping, maintenance and EVA training. On top of that, the crews still had to master flying the Apollo CSM to the station, rendezvous and dock with it, undock at the end of the missions, and then complete a re-entry and ocean recovery.

Total training time for Skylab 2 reached 2,187 hours (for the 28-day, or 672-hour mission), 2,154 hours for Skylab 3 (the 59-day, or 1,427-hour mission) and 2,059 hours for Skylab 4 (the 84-day, or 2,017-hour mission). [27]

Apollo 16 (April 16 – 27, 1972)

Flight crew: John W. Young (CDR), Thomas K. MATTINGLY II (CMP), Charles M. DUKE, Jr. (LMP)
Backup crew: Fred W. HAISE, Jr. (CDR), Stuart A. ROOSA (CMP), Edgar D. MITCHELL (LMP)
Support crew: Philip K. Chapman, Anthony W. England, Henry W. HARTSFIELD, Jr.
Spacecraft: Casper (CSM-113), Orion (LM-11), LRV-2
Launch Vehicle: Saturn V (AS-511)

Objective: 10th manned Apollo mission; 5th manned lunar landing (J-2)
Duration: 11 days 1 hour 51 minutes 25 seconds
Capcoms: (Group 5/7 only) IRWIN, HAISE, MITCHELL, ROOSA, FULLERTON, HARTSFIELD, PETERSON, and OVERMYER

Apollo 16 almost resulted in a second cancelled landing when, in lunar orbit with the LM undocked, the SPS engine on the SM failed and had to be brought back online before the LM was allowed to continue its decent. The landing at the Descartes site in the lunar highlands was achieved on April 21. Three surface activities totaled 20 hrs 14 mins (Apr 21, 7 hrs 11 mins; Apr 22, 7 hrs 23 mins; Apr 23, 5 hrs 40 mins) during a surface stay time of 71 hrs 2 mins. Once again the CSM carried a SIM Bay experiment package, this time operated by TK Mattingly during the CSM's 64 orbits (125 hrs 53 mins). On April 25, during the flight home, Mattingly conducted the second trans-Earth EVA (1 hr 24 mins), being assisted from the CM hatch by Charles Duke.

Skylab prime crews (Top, L to R): Pete Conrad, Joe Kerwin and PJ Weitz, SL-2. (Left, top to bottom): Al Bean, Owen Garriott and Jack Lousma, SL-3. (Right, top to bottom): Jerry Carr, Ed Gibson and Bill Pogue, SL-4.

SHUTTLE AUTHORIZED

On April 20, 1972, as Apollo 16 prepared to land on the Moon, the U.S. Congress authorized the NASA budget, which included a vote to continue the development of the Space Shuttle. The day after Congress passed the bill to develop the program, Charlie Duke and John Young stepped onto the lunar surface and commented that America and NASA needed the Space Shuttle. With the program now authorized, a new Shuttle Branch was established in the Astronaut Office and, after completing his Apollo 16 assignments, Don Peterson was reassigned to it. Fred Haise, meanwhile, requested a one-year leave of absence, as he had been involved in continuous mission support, backup duties, or in training since November 1966.

Though the Shuttle was the future direction, there remained one more Apollo mission to fly, but there were changes to the backup crew to support it. On May 23, those changes were formally announced, and the same release also revealed that two astronauts from the Class of 1966 had decided to leave the agency. [28]

Effective July 1, the original backup crew for Apollo 17 (Dave Scott, Al Worden and Jim Irwin) were to be replaced by Apollo 16 astronauts John Young and Charlie Duke, together with Stu Roosa. Originally, Ken Mattingly was to have been the replacement backup CMP, but was not assigned at his own request so that he could spend more time with his young family (his first son was just ten days old). Like Haise, he had been in constant training on several crews since 1966. Instead, he was assigned to the Shuttle Projects Office, together with Scott and Worden, and was replaced on the Apollo 17 backup crew by Roosa.

The two who were resigning were Jim Irwin, who revealed his intention to leave the agency and retire from the USAF effective July 31, 1972, and Ed Mitchell, who would leave NASA and retire from the USN effective October 1. Irwin was the first Group 5 astronaut to leave the Office following a space flight, and the day after his departure he announced the creation of the High Flight Foundation, in Colorado Springs, Colorado, for which he became President and Chairman. When Ed Mitchell left NASA on October 1, he established Edgar D. Mitchell Associates in order to focus on his interest in the paranormal. [29]

On May 24, the day after the announcement of crew changes to Apollo 17, U.S. President Richard M. Nixon and Soviet President of the Council of Ministers Alexei N. Kosygin signed an agreement between the two countries on the exploration and peaceful uses of space, which included plans for the very last Apollo CSM to dock with a Soviet Soyuz in Earth orbit during the summer of 1975. Following several years of negotiations, including an early proposal for an Apollo CSM to dock with a Salyut space station, three more Apollo seats were added to the shrinking number of opportunities to fly. As well as Skylab, there would now be the Apollo-Soyuz Test Project (ASTP).

In the Spring of 1972, an unprecedented controversy gradually began to erupt around the crew of Apollo 15, over some philatelic covers they had carried to the Moon and back the year before. Because the cost of personal life insurance for any astronaut was prohibitively expensive, it was common practice for mission crewmembers to sign first day covers in lieu of purchasing insurance. Post-flight, they would sell the highly-prized covers and place the proceeds into trust funds for their families. Prior to Apollo 15, Dave Scott had reached an agreement with a German friend to carry envelopes to the Moon on behalf of German stamp dealer Hermann Sieger, on the strict proviso that no covers were to be sold until the Apollo program had come to an end. Under this agreement, Scott, Al Worden and Jim Irwin were to receive $7,000 apiece. When the Apollo 15 mission was launched on July 26, 1971, the crew had stashed 398 commemorative covers aboard the spacecraft. Of these, 100 would be sold to the German dealer, and the crew would retain the other 298 as souvenirs of their lunar voyage. However, Sieger proved to be untrustworthy and began selling the philatelic covers to collectors soon after the mission ended. News of this deal subsequently leaked into the public domain and the covers were confiscated by an embarrassed NASA. The controversy was then blown out of all proportion, especially when the U.S. Congress became involved, and disciplinary action followed. The three bewildered astronauts were summoned to testify before a Senate committee, ironically just a year after they had proudly spoken of their mission at a Joint Meeting of Congress. They testified that they had done nothing wrong or inappropriate, arguing that it was an arrangement to which NASA had turned a blind eye on many previous space flights. In fact, the crew had carried 243 covers on the flight which had been authorized by NASA in addition to the 398 unauthorized ones.

"I think NASA management felt they had to do something," Al Worden later stated. "There had been a similar incident the previous year, when the Apollo 14 crew allegedly made a deal with Franklin Mint to bring silver medallions into space. But NASA kind of smoothed that over because the [astronaut] involved was Alan Shepard, who was a little more famous than we were. The government never said that we did anything illegal, they just thought it wasn't in good taste." [30] In view of the storm of adverse publicity, and despite never being charged with any crime, the crew reimbursed the money they had been paid, but later successfully sued the space agency for the return of their seized covers. Their astronaut careers, however, were at an end. They were replaced as the backup crew for Apollo 17 and never flew in space again. Dave Scott had earlier been mooted as a possible commander for ASTP, but this plan was quietly shelved. On July 26, 1972, he was appointed Technical Assistant to the Manager, Apollo Spacecraft Program, and later became director of NASA's Dryden Flight Research Center.

One of the heroes of the Apollo 13 mission, Jack Swigert, was another casualty of the covers scandal. He had earlier denied being involved in a similar scheme, but later admitted he had not been truthful in making this declaration and was also dropped from consideration for the ASTP mission. He, too, would never receive another mission assignment. In April 1973, Swigert took a leave of absence from the Office to accept the position of Executive Director of the Staff for House Science and Astronauts Committee in Washington D.C., a position he held until leaving NASA and government service in 1977. Technically, Swigert remained an active astronaut, but off the flight status list, as long as he remained in government service, leaving open the option of returning to the Office to resume crew training. He never took up that opportunity.

Prior to Apollo 15, Jim Irwin had already announced that he was leaving NASA after the flight, but Al Worden wanted to remain, despite losing his astronaut status. On September 11, however, he became the third member of the 1966 selection (after Bull and Irwin) to leave the Astronaut Office, taking up a new appointment as a senior aerospace scientist and research test pilot at the Airborne Science Office, NASA Ames Research Center, Moffett Field, California. [31] Worden's spaceflight and test pilot experience would be useful for a variety of programs at Ames, including participating in Space Shuttle vehicle simulations.

[Top] Skylab Rescue Crew, Vance Brand and Don Lind. [Bottom] the 56-day SMEAT crew, Dr. Bill Thornton, Bo Bobko (in LBNP Chamber) and at rear, Bob Crippen.

Two months in a tin can

In between the final two Apollo missions, and amid several departures from the Office, three astronauts spent 56 days in a Skylab simulator at MSC in support of the forthcoming workshop missions. Conducted between July 26 and September 20, the Skylab Medical Experiment Altitude Test (SMEAT) was designed to gather baseline medical, engineering and operational data to aid in planning the three manned missions the following year. The prime 'crew' for SMEAT was Bob Crippen (CDR), Bo Bobko (PLT) and Dr. Bill Thornton (ScPlt). No backup crew was assigned to the test. With the test simulating Skylab conditions as accurately as possible, apart from weightlessness, the baseline data gathered could subsequently be compared to the flight data from the three missions, to assess crew conditions over a mission duration and to compare data from the medical experiments and assess any effects of the Skylab environment. A total of sixteen experiments scheduled for Skylab were performed on SMEAT, focusing upon the cardiovascular system, the expenditure of energy in measured work tasks and monitoring the intake of food and nutrition of the crew, who followed a Skylab diet. The SMEAT crew also monitored experiment operating procedures, and evaluated hardware and each of the experiments during the test, which was conducted in the Crew Systems Division's 20-ft. chamber at MSC. Following the test, Crippen and Thornton returned to their support roles on the Skylab program, while Bobko resumed his Shuttle support duties

Apollo 17 (December 7-19, 1972)

Flight crew: Eugene A. Cernan (CDR), Ronald E. EVANS (CMP), Harrison H. Schmitt (LMP)
Backup crew: John W. Young (CDR), Stuart A. ROOSA (CMP), Charles M. DUKE, Jr. (LMP)
Support crew: Robert A.R. Parker, Charles G. FULLERTON, Robert F. OVERMYER
Spacecraft: America (CSM-116), LM Challenger (LM-12), LRV-3
Launch Vehicle: Saturn V (AS-512)
Objective: 11th manned Apollo mission; 6th and final Apollo lunar landing (J-3)
Duration: 12 days 13 hours 51 minutes 59 seconds
Capcoms: (Group 5/7 only) MATTINGLY, DUKE, ROOSA, FULLERTON, OVERMYER

Often termed "The Last Apollo," this was more correctly the 'last Apollo lunar mission,' as the CSM was used for three Skylab missions the following year and for ASTP 31 months later. In the sixth and final lunar landing within the Apollo program, LM Challenger *touched down at the Taurus Littrow landing site on December 11. It would remain on the surface for almost 75 hours, during which Cernan and Schmitt logged 23 hrs 5 mins in surface activity before returning to Evans in the CSM. During the record 147 hrs 48 min that the CSM remained in lunar orbit, Evans conducted the third program of SIM bay activities. On the way back to Earth, he completed the third and final trans-Earth EVA in 1 hr 6 min. This spacewalk was also the final 'Apollo' EVA.*

Ron Evans (right) with Gene Cernan. The last man on the Moon with the last Group 5 astronaut who flew to the Moon.

THE FINAL APOLLOS

Apollo missions to the Moon may have ended, but there remained at least four flights of the Command and Service Modules (CSM) still on the manifest. In addition to the three scheduled ferry missions to the Skylab OWS, there were the potential rescue missions, should the need arise, or a three-week final closeout mission if conditions were suitable. There was also the 1975 international docking mission with the Soviet Soyuz. Physical connection between the two craft would be made possible using a Docking Module, featuring an internal transfer tunnel and atmosphere equalization systems. Carried aloft by a Saturn IB, the Docking Module, housed in the Adapter Section previously used to protect the LM on Saturn V launches, had an Apollo drogue system at one end and a new androgynous system at the other, allowing physical connection to the Soyuz. The new system was designed to be the first universal docking system, and was the forerunner of similar systems on future spacecraft, opening up the capability of space rescue.

On January 30, 1973, the fifteen astronauts assigned to the prime and backup crews for Skylab were about two-thirds through their training when NASA announced the crewing for the joint docking mission. In command of the Apollo spacecraft would be Tom Stafford, who was joined by Skylab backup astronaut Vance Brand in the final Apollo CMP seat and

Deke Slayton as Docking Module Pilot (DMP). Slayton had recently been restored to flight status after more than a decade of medical disqualification. The American ASTP backup crew consisted of Skylab 3 astronaut Al Bean as CDR, Apollo 17 astronaut Ron Evans as CMP and Bean's Skylab 3 crewmate Jack Lousma as DMP. The final Apollo support crew consisted of four of the former MOL astronauts, Bo Bobko, Bob Crippen, Bob Overmyer and Dick Truly. [32]

The American Capcoms named for the mission were Dick Truly, Bob Crippen and Bo Bobko at MCC-Houston, and Bob Overmyer, who would be on console as the U.S. Capcom at the Soviet Mission Control (TsUP, in Kaliningrad, Moscow). Crew training over the next two-and-a-half years would take place in both the United States and the Soviet Union. It was also mentioned that full-time ASTP training for Skylab astronauts Brand, Bean, Lousma, Crippen and Truly would begin as soon as their Skylab duties had been completed. Bob Overmyer was also instrumental in developing the Crew and Ground Personnel Training Plan (ASTP 40 700), working with cosmonaut Vladimir Shatalov. This document defined study and practice sessions for flight crews, ground personnel and other support staff in both the U.S. and USSR. It also established three joint training sessions in each country over the next two years. Overmyer was also the Astronaut Office representative responsible for overseeing the engineering development of the docking hardware and operating procedures.

The ASTP astronauts (L to R): support crew Crippen, Overmyer, Truly and Bobko; prime crew Slayton, Stafford and Brand; and backup crew Lousma, Evans and Bean.

While work continued on Skylab and ASTP, there were also developments in the Shuttle program. On April 18, Fred Haise was named Technical Assistant to the Manager, Orbiter Project Office [33] at the now re-named Lyndon B. Johnson Space Center (JSC, formerly the Manned Spacecraft Center, MSC)[2].

In his new role, Fred Haise was responsible for assisting Aaron Cohen in the overall management of Shuttle Orbiter vehicle development. His departure from the Astronaut Office meant that there were now only 37 active astronauts on the flight-status list (with Swigert on assignment in Washington). This figure was expected to decrease further as more astronauts retired once the Skylab and ASTP programs had ended, during the lull between the end of Apollo in 1975 and the advent of the Shuttle later in the decade. Clearly, a new generation of astronauts would be required to be trained for the Shuttle, if the expected flight rate of one mission every two weeks came to fruition.

With the Shuttle's development intensifying, the potential for early test flights in the vehicle, though still several years in the future, saw a number of astronauts assigned to the Space Shuttle Branch of the Astronaut Office from January 1973.

After completing his Apollo 17 backup crew assignments, Charlie Duke was transferred to the Shuttle program as the Office's Technical Assistant to the Manager for Space Shuttle Systems Integration. Gordon Fullerton was also assigned to Shuttle support work after completing his Capcom duties on Apollo 17. Ken Mattingly was named Head of the Astronaut Office Operational and Engineering Support Group Shuttle Branch and was responsible for coordinating the Shuttle Branch Office, a position he held until March 1978. Finally, Stu Roosa was assigned Shuttle development work in crew training, and towards the end of 1973 he held technical assignments on the Shuttle 'Sortie Module' (or the Research & Applications Module (RAM) which subsequently became known as 'Spacelab'). In this role, Roosa travelled to the European Space Research Organization (ESRO, the fore-runner of the European Space Agency, ESA), in Noordwijk, The Netherlands.

TALLY-HO THE SKYLAB

After a decade of development, the first and only Skylab OWS left the ground on May 14, 1973, on top of the final (two-stage) Saturn V. Formed from a converted Saturn S-IVB stage and outfitted on the ground, the OWS was supposed to have been occupied by the first crew for a month, beginning the following day. However, during the unmanned ascent, aerodynamic forces tore loose the station's micrometeoroid thermal shield and ripped off one of the larger solar panels. Once in orbit, the second solar panel failed to deploy and

[2] On January 22, 1973, former U.S. President Lyndon B. Johnson (known as LBJ) died of a heart attack in Austin, Texas, aged just 64. In 1961, Vice President Johnson was instrumental in persuading President John F. Kennedy to select a manned lunar landing by the end of the decade as a national goal, to offset recent Soviet space triumphs and political embarrassments, such as the Bay of Pigs fiasco in Cuba. Johnson was a staunch space program supporter from Texas and strongly urged NASA to locate the MSC in his home state, which it did in 1962. Johnson became the 36th U.S. president following the assassination of Kennedy in November 1963, and was in office during the series of Gemini missions and the tragic fire that claimed the Apollo 1 astronauts. He witnessed the success of the first Apollo mission to the Moon with Apollo 8, before leaving office in January 1969. Following LBJ's death, there was a desire to recognize his support of the nation's space program, and America's quest for the Moon, by renaming the MSC after him. This change was made on February 17, with the formal dedication occurring on August 27, 1973.

internal temperature readings rose significantly. Consequently, the launch of the first crew was delayed until solutions to the problems could be developed. It was not a great start, and for the Group 5 astronauts preparing to live aboard the workshop, not a good omen so close to their first spaceflights.

Skylab astronaut Weitz (top left) monitors the ATM console, while Lousma (bottom), Carr and Pogue (top right) demonstrate the fun of microgravity.

Skylab 2 (May 25 – June 22, 1973)

Flight Crew: Charles Conrad (CDR), Paul J. WEITZ (PLT), Joseph P. Kerwin (ScPlt)
Backup Crew: Russell L. Schweickart (CDR), Bruce McCANDLESS II (PLT), F. Story Musgrave (ScPlt)
Support Crew: Karl G. Henize, William E. Thornton, Robert L. CRIPPEN, Henry W. HARTSFIELD, Jr.
Spacecraft: CSM-116/Skylab 1 OWS
Launch Vehicle: Saturn 1B (SA-206)
Objective: 1st manned Skylab mission
Duration: 28 days 0 hours 49 minutes 49 seconds *(new space endurance record)*
Capcoms: CRIPPEN, HARTSFIELD, Henize, Parker, Schweickart, Thornton, TRULY

The difficulties encountered by the unmanned Skylab 1 in reaching a safe orbit on May 14 had delayed the launch of Skylab 2 by eleven days, while the damaged OWS was analyzed and new plans were devised to allow the crew to repair the station and still complete the planned 28-day mission. The priority for the crew was to free the stuck solar array, making a first attempt shortly after arriving at the OWS. Standing in the open CM hatch with Kerwin hanging onto his legs, Weitz tried unsuccessfully to free the jammed array using a hooked pole. The crew endured more frustration in the eight attempts to dock with the OWS before they could finally rest. Gradually, conditions inside the station improved. Four days into the mission, they deployed a parasol sun shield out of the sun-facing small scientific airlock, which shaded the habitable section and gradually lowered the internal temperatures. A week later, Conrad and Kerwin successfully freed the stuck solar array in a dramatic and hazardous EVA, allowing much needed electrical power to surge around the workshop's systems. Weitz accompanied his commander on the final EVA of the mission, a 1 hr 44 mins sojourn on June 19, where the two men retrieved and replaced ATM film canisters and inspected the deployed solar array and parasol. During their stay, the crew still managed to complete 46 of the planned 55 experiments during 392 hours of experiment work.

Skylab 3 (July 28 – September 25, 1973)

Flight Crew: Alan L. Bean (CDR), Jack R. LOUSMA (PLT), Owen K. Garriott (ScPlt)
Backup Crew: Vance D. BRAND (CDR), Don L. LIND (PLT), William B. Lenoir (ScPlt)
Support Crew: Karl G. Henize, William E. Thornton, Robert L. CRIPPEN, Henry W. HARTSFIELD Jr.,
Spacecraft: CSM-117/Skylab 1 OWS
Launch Vehicle: Saturn 1B (AS-207)
Objective: 2nd manned Skylab mission
Duration: 59 days 11 hours 9 minutes 4 seconds *(new space endurance record)*
Capcoms: CRIPPEN, HARTSFIELD, Henize, Parker, Schweickart, Thornton, TRULY, plus McCANDLESS, Musgrave

Just five weeks after the Skylab 2 crew returned to Earth, the next team was on its way to the OWS, recording one of the shortest gaps between American missions. The flight had been brought forward due to concerns over the integrity of the station because of its *thermal difficulties. Despite the problem of a damaged RCS system on the SM, which initiated a potential rescue flight by Brand and Lind, the mission lasted its full duration. This was actually three days longer than originally planned, due to a requirement for better lighting conditions at recovery. During the mission, Lousma tested the prototype manned maneuvering unit inside the OWS and performed two EVAs with Owen Garriott, totaling 11 hrs 1 min (Aug 6, 6 hrs 31 mins, Aug 24, 4 hrs 30 mins). During their first trip outside, the pair erected a twin-pole sun shade assembly over the parasol that had been deployed during SL-2, designed to further improve thermal conditions inside the workshop. On the second EVA, Lousma and Garriott retrieved and replaced ATM film canisters. This crew completed over 1,081 hours of experimentation during the record-setting mission.*

While the Skylab 3 mission was on orbit, news came through that Fred Haise had been injured in a plane crash at about 6:40 pm on August 22. Haise was flying a vintage WWII BT-13 training plane, owned by the Confederate Air Force and painted to resemble a Japanese WWII aircraft. Flying from Angleton, Texas, Haise had been in a traffic pattern above the Galveston airport when his plane's engines "just quit," as Haise later told NASA officials. He crash-landed near Scholes Field in Galveston, suffering second degree burns to over 50 percent of his body and a few third degree burns on his legs. He was admitted to John Sealy Hospital in Galveston, where his prognosis was reported to be good with stable vital signs. Early indications suggested that skin grafting would not be necessary. It was another lucky escape for Haise, just over three years after flying on Apollo 13.

Skylab 4 (November 16, 1973 – February 8, 1974)

Flight Crew: Gerald P. CARR (CDR), William R. POGUE (PLT), Edward G. Gibson (ScPlt)
Backup Crew: Vance D. BRAND (CDR), Don L. LIND (PLT), William B. Lenoir (ScPlt)
Support Crew: Karl G. Henize, William E. Thornton, Robert L. CRIPPEN, Henry W. HARTSFIELD, Jr., plus Lenoir
Spacecraft: CSM-118/Skylab 1 OWS
Launch Vehicle: Saturn 1B (AS-208)
Objective: 3rd and final Skylab manned mission
Duration: 84 days 1 hour 15 minutes 37 seconds *(new space endurance record)*
Capcoms: CRIPPEN, HARTSFIELD, Henize, Parker, Schweickart, Thornton, TRULY, plus Musgrave

This final mission to the OWS not only set a third U.S. endurance record in just over six months, it also shattered the world endurance record. The 84-day record would not be surpassed until March 1978 by the Soviets and until July 1995 by an American astronaut. Described as 'an open-ended mission,' the flight was extended from 56 to 84 days to gain the most from the hardware, experiments and crewmembers. It proved to be the penultimate American manned mission of the 'pioneering era' of human spaceflight. For an all-rookie crew, adjusting to spaceflight conditions, keeping pace with – and trying to surpass – the previous crew's achievements and dealing with new tasks and experiments proved challenging. Despite some tetchy days early in the mission, the crew and controllers rallied round and delivered some of the most impressive returns from any spaceflight to date. A total of 56 experiments, 26 science demonstrations and over 338 *hours of solar observations were completed, along with several observations of Comet Kohoutek. Either Carr or Pogue participated in the four EVAs, once together and the other three pairing one of them with Gibson. Each EVA was mainly concerned with the retrieval and replacement of ATM film canisters, but also featured minor repairs, small experiments and visual observations of Kohoutek. On November 22, Pogue accompanied Gibson on the first EVA (6 hrs 33 mins). Then, on the first EVA conducted on Christmas Day, Carr joined Pogue for the second EVA (7 hrs 1 min). Four days later, on December 29, Carr and Gibson were outside again (3 hrs 28 mins). The same pair completed the last EVA of the mission and the program on February 3, 1974 (5 hrs 19 mins). This would also be the last American spacewalk for nine years, until the advent of Space Shuttle EVA capabilities on STS-6 in April 1983. For a time, it was hoped that Skylab could be revisited and reoccupied, perhaps by a Shuttle flight, but the OWS was never visited again. Increased solar activity forced its descent into the atmosphere and re-entry in July 1979, well before any Shuttle flew in orbit, or any mission could be planned to return to America's iconic first and, at the time of writing, only national space station to host crews.*

Three days after the last Skylab mission left Earth en route for the workshop, nine astronauts, including all three prime crewmembers, the backup crew, Gene Cernan, and support astronauts Overmyer and Bobko, departed the USA for Moscow on a two-week ASTP familiarization visit. The following month, on December 7, astronauts Cernan, Haise and Duke were assigned managerial roles in the Shuttle Office. Duke became the Deputy Manager for Advanced Planning in the same department in which he had been working. This was a post he held until leaving NASA at the end of 1975.

LOST DREAMS BUT NEW GOALS

By the second month of 1974, the final Skylab mission was complete and, other than some post-flight activities, the focus shifted to ASTP. Those active astronauts not involved in the joint docking mission were reassigned to Shuttle development issues, completed over the next couple of years.

Gordon Fullerton was assigned to supporting developments in the recovery mission phase, and controls and display hardware. Bruce McCandless was given assignments in the EVA mission phase and hardware. Over next few years, he also became a specialist in Shuttle EVA operations, equipment and procedures and served in the Operations Mission Development Group of the Shuttle Office, working on pre-launch and ascent procedures. He was also the Astronaut Office point of contact for all MMU issues. Hank Hartsfield worked on simulations of the orbiter's flight control systems and hardware. PJ Weitz was assigned to track crew station hardware development and, using his Skylab experiences, Earth resources studies from the Shuttle. Don Peterson worked on the on-orbit systems mission phase, navigation, communications and tracking hardware, and development of the RCS/OMS hardware. In May 1974, his Skylab duties completed, Jerry Carr became the Head of the Shuttle design support group at JSC. The following month, Bill Pogue was assigned Shuttle development work in the launch and abort mission phase and in developing the pilots' handbook.

Following his Skylab assignments, Don Lind also worked on various Shuttle development issues until 1975, when he took a sabbatical to conduct post-doctoral studies at the University of Alaska Geological Institute. Living near to the Space Center, Lind cycled to work each day, but on July 29, 1974, a car knocked him off his bicycle on NASA Road 1. Lind was taken to the Clear Lake Hospital Emergency Room where he needed surgery. His injuries included fractures of his lower left leg, left ankle and right index finger between the knuckle and the wrist. He remained in hospital to recover from his injures before returning to his duties at JSC. [34]

SHAKING HANDS WITH THE SOVIETS

Following the 1972 agreements between the U.S. and the USSR, several groups worked behind the scenes to develop a firm docking mission, planned for the summer of 1975. This was to be the fifteenth and final launch of an Apollo CSM, the fifth and final flight of a Saturn 1B with a crew on board, and would close the era of one-shot spacecraft begun 14 years earlier with Alan Shepard's Mercury MR-3 suborbital lob down the Atlantic Missile Range.

Though the Apollo missions had ended three years previously, and training on Skylab had emphasized the scientific program and OWS, the Skylab crews still required some CSM training for the ascent and entry phases of each mission. For Apollo-Soyuz, however, a significant amount of Apollo CSM training was necessary; indeed, this flight was similar to Apollo 7 as an extended Earth-orbital space flight, or even Apollo 9, but this time the target was not an S-IVB or LM, but a Soyuz spacecraft.

This training would take place in the United States and the Soviet Union and would involve lessons in Russian language skills for the Americans and in English for the Russians. The preliminary familiarization visit to the USSR between November 18 and December 1, 1973 was followed in April 1974 by the first formal joint ASTP training session, held at NASA JSC. The second joint session was held between June 24 and July 11 at the Cosmonaut Training Center TsPK, near Moscow in Russia, where the focus was on Soyuz familiarization training. The final joint session of the year occurred during September 9-27 at JSC, focusing this time on Apollo CSM/DM familiarization training. In February (7–28) 1975, the astronauts and cosmonauts were back in the U.S. for a visit to KSC in Florida, before heading to Texas for further training at JSC. The final joint training session was held in Russia from April 14 to 30 and included a visit to the Baikonur Cosmodrome. Generally, the training progressed smoothly, but as well as having to master the Russian language and the way the Soviets managed their program, the American contingent also had first-hand experience of not-so-hidden clandestine surveillance techniques in hotel rooms, which they learned to play to their advantage at times, suggesting things which would make their visit more comfortable.

The official ASTP Program History, published by NASA in 1978, [35] detailed the crew training program for ASTP, specifically for Group 5 astronaut Vance Brand, who was reported to have completed 2,789.2 hrs of training for the mission. The breakdown for this included 276.9 hrs of briefings and reviews, 302.3 hrs of various systems training, and 474.2 hrs on the simulators.

Overmyer and Brand familiarize themselves with ASTP systems, but in Russian.

Back in late 1966, Brand had been assigned to the Astronaut Office CSM development group and probably had more experience on Apollo CSM systems and procedures than any other astronaut in the office, having served on test, support and backup crews. However, he still received over 55 hrs of briefings and reviews on the CSM and logged all his simulator training time in the CM/Docking Module simulator, rather than the CM procedures simulator that Stafford and Slayton trained in. As this was an 'international mission,' Brand also received 923.5 hrs in Russian language studies, which worked out at about fifteen hours a week over an eighteen-month period. An additional 812.3 hrs was spent on preparing for joint crew activities for when the two spacecraft were docked and the crew transfer took place.

Stafford completed about 100 hrs less than Brand, at 2,689.7 hrs, while 'rookie' Slayton, though the longest-serving space explorer on either the American or Russian teams, spent 3,075.5 hrs training for ASTP. Both men also spent far more time on Russian language studies than Brand, who noted in his 2015 biography that "teaching American ex-fighter pilots Russian was a challenging assignment for our group of professors." [36]

ASTP 'Apollo 18' (July 15 – 24, 1975)

Flight Crew: Thomas P. Stafford (CDR), Vance D. BRAND (CMP), Donald K. Slayton (DMP)
Backup Crew: Alan L. Bean (CDR), Ronald E. EVANS (CMP), Jack R. LOUSMA (DMP)

Support Crew: Karol J. BOBKO, Robert L. CRIPPEN, Robert F. OVERMYER, Richard H. TRULY
Spacecraft: CSM-111
Launch Vehicle: Saturn 1B (AS-210)
Objective: 1st international manned docking mission (with Soviet Soyuz 19)
Duration: 9 days 1 hour 28 minutes 24 seconds
Capcoms: BOBKO, CRIPPEN, OVERMYER (Tech Advisor, MCC-Kaliningrad near Moscow, USSR), TRULY

It had been seventeen months since the end of the Skylab 4 mission when the CSM of 'Apollo 18' returned American astronauts to orbit, the longest hiatus since Gemini 12 and Apollo 7. By the time the crew was in orbit, the two Soviet cosmonauts, Alexei Leonov and Valeri Kubasov, had already been there for seven-and-a-half hours. Over the next two days the chase was on, culminating in the historic docking of the Apollo spacecraft with Soyuz 19 on July 17. Several crew transfers were made over the next two days, using the DM to adjust the internal atmospheres between the two craft. All five crewmembers visited each other's spacecraft, and conducted ceremonial activities and several telecasts. In total, Brand spent 6 hrs 30 mins inside the Soyuz during the docked phase. On July 18 and 19, several joint docking and rendezvous and primary operations were conducted before the two spacecraft finally separated to complete their own individual programs. The Soyuz returned to Earth on July 21, while Apollo remained in orbit until July 24, conducting Earth observations and other experiments and making the most of the final days in space by American astronauts until the advent of Shuttle.

The splashdown of the last Apollo capsule on July 24, the sixth anniversary of the return of Apollo 11, was not as straightforward as planned. Brand did not activate two switches to shut off the RSC thrusters and activate the drogue parachutes. In the confusion of activities, and possibly not hearing the command, the action was overlooked until Brand noticed that the drogues had not deployed and hit the manual switches. The oscillations caused the RCS to continue firing, as they had not been deactivated. Stafford shut them down manually but not before nitrogen tetroxide had entered the cabin via an open pressure feed valve, causing the astronauts to cough and choke. After hitting the water, the capsule turned over into the Stable II position, effectively trapping the gaseous atmosphere inside the spacecraft until it righted. Brand fell unconscious for a short while, being revived after 40-50 seconds using an oxygen mask. On the recovery aircraft carrier, the three men were examined and their chests X-rayed, revealing 'white' lungs where the gas had combined with water in the lungs to create a weak nitrous acid. The crew was shipped to Tripler Military Hospital in Hawaii for a week after landing, where they were given a cortisone protocol which saved their lungs. This was followed by a few days of recuperation at the Kaneohe MCAS on the island. It was a near thing and an unfortunate end to the historic flight, which was the genesis for cooperative ventures at Mir and ISS twenty years later. The event seemed to have no lasting effect on Brand, who subsequently returned to space on three Shuttle missions. Both Stafford and Slayton retired after the historic international flight.

ASTP CM Pilot Brand, the last member of Group 5 to fly in an Apollo spacecraft.

THE PASSING OF AN ERA

After completing their various ASTP duties, the astronauts who had been assigned to support the mission moved to new development roles for the forthcoming Shuttle program. Ron Evans was assigned to operational aspects of the ascent phase for STS/OFT missions and Jack Lousma worked with the Space Shuttle Development Branch design support team on defining the layout of the orbiter flight deck. Each of the Group 7 astronauts was assigned to various technical roles.

On September 1, both Jerry Carr and Bill Pogue retired from military service. [37] Col. Carr, it was announced, would remain at NASA as a civilian astronaut after 22 years in the U.S. Marine Corps. Pogue, an Air Force colonel with over 24 years of service, announced he would be retiring from both NASA and the USAF to become Vice President of the High Flight Foundation in Colorado Springs, the evangelistic organization founded by Jim Irwin in 1972. On the very same day, Al Worden resigned from NASA Ames to accept a position with High Flight, and on September 12, NASA announced that Charles Duke would be leaving the agency effective January 1, 1976 and retiring from the USAF with the rank of colonel. His departure would reduce the total number of active astronauts to just 29. [38] One of those remaining, Vance Brand, was assigned to Shuttle development duties in November, following the completion of his post-flight ASTP activities.

Over a period of 9 years and 8 months, members of the fifth class of NASA astronauts had been involved in most of NASA's manned space programs. They had completed training for flights on Apollo hardware; fulfilled some ground support roles on the final flights in the Gemini program; assisted in the recovery of the program from the fatal Apollo 1 pad fire; performed numerous important ground tests of Apollo and AAP hardware and systems; supported the key Apollo missions leading to the first landing on the Moon; and supplied prime and backup crewmembers for five Apollo missions, three Skylab resident crews and the first international rendezvous and docking mission crew. The seven who had transferred from MOL in 1969 had supported the latter four Apollo missions, Skylab and ASTP over the ensuing six years. Now, as 1975 ended, the remaining members of Groups 5 and 7 joined the other active astronauts in the Office for new assignments in the Space Shuttle program.

By December 1975, the remaining active members of the 1966 selection were Vance Brand, Jerry Carr, Joe Engle, Ron Evans, Fred Haise, Don Lind, Jack Lousma, Ken Mattingly, Bruce McCandless, and PJ Weitz. Technically, Jack Swigert was also available as an active (but off the flight list) astronaut. These ten (eleven) astronauts, together with the seven former 'MOL-Guys', comprised most of the complement of the Astronaut Office. But with the projected flight rate of the Shuttle forecasting a launch every two weeks, and atmospheric tests of the first orbiter planned for 1977, more astronauts would clearly be required within the next few years. With the Apollo era completed, big changes would have to be made in the way the Office supported the Shuttle program, and for the first few years at least, members of the Classes of '66 and '69 would play prominent roles in that transition; on the ground in support roles, in space and eventually in management positions.

References

1. Fred Haise, letter to Colin Burgess, November 28, 1996
2. Email to the authors from Michael Cassutt, February 21, 2001
3. Jack Lousma, letter to Colin Burgess, November 18, 1996
4. *Science & Applications Expands*, MSC Roundup Vol. 9, No. 7, January 30, 1970, p. 1
5. ***Don Lind, Mormon Astronaut***, Kathleen Maughan Lind, Deseret Book Co., Salt Lake City, Utah, 1985
6. MSC News, MSC-70-34, March 26, 1970
7. ***NASA's Scientist-Astronauts***, David J. Shayler and Colin Burgess, Springer Praxis, 2007
8. Robert Pearlman, collectSPACE forum post, December 14, 2012. Available at: http://www.collectspace.com/ubb/Forum29/HTML/000099.html. Last accessed December 17, 2016
9. *Apollo Summary Report*, NASA LBJ Space Center, Houston, Texas, April 1975, JSC-09423 Section 6.2 Flight Crew Training Program
10. Data from each mission flown by a Group 5 or 7 astronaut between April 1970 and December 1990 is taken from ***Praxis Manned Spaceflight Log 1961-2006***, Tim Furniss and David J. Shayler, with Michael D. Shayler, Springer Praxis, 2007

11. Memo from Donald K. Slayton, Director of Flight Crew Operations, to Manager Skylab Program, Subject: *Skylab organization within the Astronaut Office*, May 27, 1970, copy in the AIS archives
12. *Apollo 15 crew views Canadian Crater Blast*, MSC Roundup, Vol. 9, No. 20, July 31, 1970
13. *NASA Reviews Remaining Apollo Flights*, MSC Roundup, Vol. 9, No. 21, August 14, 1970, p. 2
14. *Paine Outlines Apollo Future*, MSC Roundup, Vol. 9, No. 23, September 11, 1970
15. Online article: *45 years later, astronaut Fred Haise reflects on the events of Apollo 13*, http://www.gulflive.com/news/index.ssf/2015/04/45_years_later_astronaut_fred.html. Last accessed, December 18, 2016
16. ***To Rule the Night***, James B. Irwin with William A. Emerson Jr., A. J. Holman Company, 1973, p. 213
17. MSC News, MSC-71-01, January 15, 1971
18. ***Smoke Jumper, Moon Pilot: The remarkable life of Apollo 14 astronaut Stuart Roosa***, Willie G. Moseley, Acclaim Press, 2011, p. 157
19. MSC News, MSC-71-09, March 3, 1971
20. MSC News, MSC-71-56, August 13, 1971
21. *A New Goal for Dropped Astronaut*, James Maloney, *Houston Post* newspaper article, September 8, 1971
22. *Engle to Soar into Astronaut Hall of Fame*, the *Salina Journal* newspaper (Salina, Kansas), June 19, 2001, p. 1
23. Joe Engle: interview by Rebecca Wright for NASA's Oral History Project, Houston, Texas, May 24, 2004
24. *LM Pilot Charles M. Duke Hospitalized*, MSC News, MSC-72-02, January 4, 1972
25. *Skylab Flight Crews Named*, MSC News, MSC-72-17, January 18, 1972
26. Email from Michael Cassutt to the authors, February 20, 2001
27. ***Skylab: America's Space Station***, David J. Shayler, Springer Praxis 2001, pp. 126-140
28. *Astronauts Mitchell and Irwin to Retire*, MSC News, MSC-72-113, May 23, 1972
29. *Astronaut Mitchell retires*, MSC News, MSC-72-206, October 2, 1972
30. *Apollo 15's Al Worden on Space and Scandal*, Julie Mianecki, Smithsonian *Air & Space* magazine, issue October 2011
31. *Worden Assigned to Ames Research Center,* MSC News, MSC-72-197, August 31, 1972
32. *ASTP Crew Named*, MSC News, MSC-73-12, January 30, 1973
33. *Haise moves to Orbiter Project Office*, JSC News, JSC-73-41, April 18, 1973
34. *Don Lind injured*, JSC Roundup, Vol. 13, No.7, August 2, 1974, p. 1
35. ***The Partnership: A History of the Apollo Soyuz Test Project***, Edward C. Ezell and Linda N. Ezell, NASA SP-4209, 1978, p. 313
36. ***Flying Higher and Faster***, Vance Brand, Mira Digital Publishing, 2015, p 94
37. *Carr, Pogue to Retire from Military Service*, NASA News 75-70, August 22, 1975
38. *Astronaut Duke to leave NASA*, JSC News, JSC-75-74, September 12, 1975

10

Riding 'The Stack'

"This is the world's greatest
all-electric flying machine, I'll tell ya that."
John Young, Commander STS-1,
following the landing of Space Shuttle *Columbia*,
Edwards AFB, California, April 14, 1981.

By January 1976, the focus for manned spaceflight at NASA was the development of the Space Shuttle system and preparations for the ground and airborne test programs over the next couple of years, hopefully leading to the first orbital flight by the end of the decade.

The first production vehicle off the assembly line – OV-101, named *Enterprise* – would be test-flown off the back of a converted Boeing 747 aircraft known as the Shuttle Carrier Aircraft (SCA). Released at altitudes of up to 5 miles (8 km), *Enterprise* would complete a program of free-flight testing and unpowered landings at Edwards Air Force Base (AFB), to demonstrate the aerodynamic handling characteristics of an orbiter returning from space during the final phase of its mission. The tests were also designed to investigate the landing and rollout phases of the mission, as well as the accuracy of landing on the desert and concrete runways. They were also vital in evaluating the orbiter's deceleration, braking and steering characteristics as it rolled to a stop.

Upon completion of the Approach and Landing Test (ALT) program, *Enterprise* would be taken firstly to Marshall, then Kennedy and finally Vandenberg Space Center, to be used as a test and verification vehicle for simulated launch processing. Then OV-102 (*Columbia*) would complete a series of Orbital Test Flights (OFT), qualifying the Solid Rocket Booster/External Tank/Orbiter Vehicle (SRB/ET/OV) combination for space flight before declaring the Space Transportation System (STS) 'operational' and ready to complete a wide range of missions, using a fleet of at least four (possibly five) orbiters.

D.J. Shayler, C. Burgess, *The Last of NASA's Original Pilot Astronauts*,
Springer Praxis Books, DOI 10.1007/978-3-319-51014-9_10

APPROACH AND LANDING TEST CREWS

On February 24, 1976, NASA announced the small team of astronauts that had been assigned to the ALT program planned for 1977. They were all chosen from either Group 5 or Group 7 astronauts, who were now the primary members of the Astronaut Office. The first ALT crew named was Commander (CDR) Fred Haise and Pilot (PLT) Gordon Fullerton, and the second was CDR Joe Engle and PLT Dick Truly. Each crew would back up the other during the series of flight tests, flying alternate missions. Bo Bobko and Bob Overmyer were assigned as support crewmembers and alternate Capcom/prime T-38 chase pilot for each flight.

The two ALT Crews. (L to R): Fullerton and Haise, Engle and Truly, in front of OV-101 *Enterprise.*

The change of guard

The next two years would see significant changes in the Astronaut Office, as it absorbed the huge shift from Apollo to the Shuttle. One of the highlights was the announcement of a forthcoming selection process for an eighth group of astronauts, the first to be chosen specifically to crew future Space Shuttle missions. On July 6, 1976, two days after the United States celebrated its bicentennial, NASA issued the call for its first intake of astronauts in almost ten years. This time, the space agency was looking for about 30 applicants, to be selected by December 1977. They would go on to complete a two-year training and evaluation program as Astronaut Candidates, or Ascans, *before* being classified as 'astronauts.'

Two categories of Ascans were to be selected. The Pilot would join the mission commander (ideally a veteran astronaut) as the flight deck crew, monitoring and controlling the vehicle during the launch, orbital and landing phases, and maintaining the onboard systems. The Mission Specialist (MS) category was a new position within the Office, and would be responsible for assisting the CDR and PLT, as well as coordinating the flight plan, monitoring the use of consumables and managing the payload and experiments. For the first time, women and minority candidates were urged to apply. The new Shuttle system required more astronauts than just the flight deck crew and was designed to reduce the stresses and loads of launch and landing, so some of the criteria that had restricted applications in the early groups could now be relaxed. The seven groups of NASA astronauts selected since 1959 had brought 73 male pilots and scientists (now called Senior Scientist Astronauts) into the program. There remained only 31 of these still eligible for flight assignment as active astronauts; 28 were still at the Johnson Space Center (JSC), while the other three were holding down government positions in Washington D.C. [1]

On-going developments in the Shuttle program prompted Bill Pogue to re-join NASA on April 18 as an active astronaut, and he was assigned to the Earth Resources Program Office (ERPO), studying the potential for Earth observation from space. One of the projects he worked on was the early payload for STS-2, including the possibility of returning to Skylab using the Shuttle as the docking vehicle. Meanwhile, Ron Evans and PJ Weitz retired from the USN, on April 30 and June 1 respectively, and both continued as 'civilian astronauts.' The report announcing Weitz's USN retirement [2] gave his present role as "working on payloads and flight crew documentation for the Shuttle."

In the fall of 1976, Don Lind also returned to JSC, after completing his doctorate work at the University of Alaska. He was assigned to the Operations Mission Development Group, responsible for developing payloads on the early Shuttle flights. Over the next five years, Lind would work on the payloads assigned to the first four Shuttle missions under the OFT program and on the science program for what eventually became Spacelab 3. Work on the Spacelab module had been in progress for several years since the early 1970s, mostly involving some of the scientist astronauts in tests, simulations and evaluations. [3] Occasionally, some of the pilot astronauts participated in hardware reviews and developments for components intended to fly on the Shuttle, especially those who had experience in Skylab. One such visit to the Marshall Space Flight Center (MSFC) in Huntsville, Alabama, where the module was being managed, included PJ Weitz, who accompanied scientist astronauts Kerwin, Lenoir, Parker and Group 3 astronaut Rusty Schweickart. The group familiarized themselves with equipment onboard the Spacelab mockup and were briefed on Spacelab subsystems and proposed crew activities. [4] The results of such activities were then summarized for the rest of the Office in memos and during the weekly Monday morning pilots' meetings.

A NEW TRAINING PROGRAM

With the retirement of Apollo-class spacecraft and the introduction of the Shuttle, even the most experienced astronauts had to return to the classroom, to train for missions which would return to a runway and not end up in the ocean. Their previous academic and survival training helped, as did the hundreds of hours spent in Apollo simulators and training sessions, and of course their experiences from the various missions. But the Shuttle system was very different from what had gone before; even learning to 'fly' the orbiter through the atmosphere – as a 100-ton glider – for a one-shot landing attempt was a new challenge for the pilots. To help them become accustomed to the handling qualities of the orbiter, NASA purchased a Gulfstream business jet and incorporated duplicate Shuttle controls in the left-hand pilot position, to allow future Shuttle flight deck crews to practice approach and landing techniques. On the real orbiter, each landing would have to be right first time, with no opportunity for a missed approach and second attempt.

On September 17, to great fanfare, Orbiter OV-101 *Enterprise* was rolled out of the assembly building at the Rockwell International facility in Palmdale, California. Unlike the later orbiters, *Enterprise* had neither engines nor heat-protecting tiles, and was therefore incapable of orbital flight. Among the 2,000 spectators and dignitaries present that day were six members of the original cast of the TV series "*Star Trek*." The original name planned for the new winged vehicle was *Constitution*, but when dedicated fans of the TV series (known as 'Trekkies') heard of this, they initiated a campaign and sent hundreds of thousands of letters to President Gerald Ford, pleading for the name to be changed to *Enterprise* by way of homage to the TV series and its creator, Gene Roddenberry. Their campaign worked, and President Ford directed NASA to change the name of the new orbiter to that of the fictional starship *Enterprise*. [5] Also witnessing events were Haise, Fullerton, Engle and Truly, the four astronauts chosen to crew the vehicle for the ALT flights the following year. Termed the flagship of a new era in space transportation, Senator Barry M. Goldwater (R. Arizona) stated that the Shuttle was "probably the best investment the U.S. Congress has ever made." The astronauts were not about to disagree with him.

One week later, on September 24, 1976, Bob Overmyer conducted simulated T-38 chase flights at White Sands, New Mexico, ahead of becoming the first astronaut to fly the Shuttle Training Aircraft (STA) from White Sands on October 7.

Training for a Shuttle Mission

During the Shuttle program (1981-2011), training for each mission varied considerably, based upon the mission itself, the hardware, the experience of the crew, and the introduction of new procedures and techniques as the program matured, both naturally and following the two serious accidents in 1986 and 2003.

Details of Shuttle crew training are beyond the scope of this current volume, but basically each crew was required to complete a program that encompassed: a refresher course in the various systems on the orbiter; flight operations and mission-specific profiles; flight-specific training, which included any payload deployment and retrieval systems such as the Remote Manipulator System (RMS); the deployment and retrieval of payloads; the various carriers, such as upper stages, Spacelab pallets and modules; and the variety of attached payloads, such as the small Get Away Special (GAS) canisters and Hitchhiker packages attached to the sides of the payload bay. They also trained for the experiments carried on the mid-deck, proximity operations and rendezvous (but not docking training until the early 1990s, after the Group 5 and 7 astronauts had all departed the Office), Extra Vehicular Activity (EVA, or spacewalking), and a series of test and supplementary objectives designed to evaluate new procedures and items of hardware prior to their operational use. It normally took a full year to train for a Shuttle mission, though this varied considerably depending upon the objectives and complexity of the assigned flight. In the early days of the program, astronauts tended to find that missions were delayed, payloads cancelled and the orbiter to which they had originally been assigned was changed.

Jerry Carr practices emergency egress procedures from a Space Shuttle mockup at JSC (Courtesy Ed Hengeveld). [Inset] Weitz performs an underwater EVA simulation on a mockup of Spacelab.

By the end of the 1970s, all the active members of the 1966 and 1969 groups were now senior astronauts, even if some were yet to fly in space. Of the seven still active from the 1966 selection, four (Brand, Lousma, Mattingly and Weitz) had previously flown in space, while the other three (Engle, Lind and McCandless) had yet to do so. All seven of the 1969 selection (Bobko, Crippen, Fullerton, Hartsfield, Overmyer, Peterson and Truly) were still active, but were also yet to fly. They were all eligible for assignment as either Pilot (unflown rookie) or Commander (flown veteran, including former X-15 pilot Joe Engle) and therefore trained to fly the orbiter, including flying the STA in which they practiced the final approach and landing profile up to just a few days prior to launch. They also operated the RMS and performed the maneuvers required to rendezvous with and grapple payloads, deploy satellites, and support early scientific studies and research.

During the development of Shuttle EVA techniques, many of the 14 trained to conduct contingency EVAs, though only two ever completed a scheduled EVA, both while flying as MS. While they were all technically eligible to fly eventually as CDR, three of them – Don Lind, Bruce McCandless and Don Peterson – flew their only missions as MS.

A chance to fly

Almost from the moment he had been selected to the astronaut program, and despite his flying qualifications, Don Lind had been considered as more of a scientist astronaut than a pilot by NASA management. Having gained his piloting credentials in the U.S. Navy, Lind had followed an academic and scientific career, earning a PhD in High Energy Nuclear Physics. He then served as a space physicist at NASA's Goddard Spaceflight Center for two years prior to his selection. His early Office assignments gave him the experience to be considered as an LM Pilot on a later Apollo landing crew, but missions were cancelled and the program shortened before he could be named to one. After transferring to Skylab, Lind was disappointed not to be selected as Science Pilot on a prime crew, instead being named as backup PLT for the second and third mission and as PLT on Skylab Rescue. Had the cancelled Skylab B flown, Lind believed he would have been assigned as a second Science Pilot rather than a CM Pilot. In 1974, he had been assigned to the Science and Applications Directorate and from that point, Lind was considered a scientist astronaut/mission specialist. Despite his lack of flight crew assignments, he decided to wait for a chance to fly on the Shuttle as MS, having not trained on the STA to qualify to fly the orbiter. His science background would prove useful in being assigned to a Spacelab mission.

Bruce McCandless had trained on the STA between 1980 and 1983 and was eligible for assignment as PLT on an early flight. Instead, he was offered the opportunity to test fly the Manned Maneuvering Unit (MMU) as MS. This was a plum assignment in the Office and McCandless, who had worked on the MMU's development, chose it over perhaps flying his only mission as PLT on an early Spacelab mission. He was also not a test pilot, and could not really compete with the flying experiences of either the former MOL astronauts, nor many of the new pilots selected in Group 8 in January 1978 who would be available for flight crew assignments from 1982. McCandless had also worked for years on helping to develop EVA techniques to support the deployment and servicing of the Hubble Space Telescope (HST), an assignment that helped secure his second mission.

Don Peterson's hopes of being assigned as PLT on an early Shuttle mission were temporarily hindered by some undefined medical issues that appear to have restricted his time in the T-38 to maintain his flying proficiency and therefore qualify in the STA. His opportunity to fly at least once on the Shuttle came about partly because of the change in management at the Flight Crew Operations Directorate at JSC in January 1976. At the time, there was a sense of obligation to fly unflown active astronauts on early Shuttle flights, but mostly it was a one-flight opportunity. The new astronauts arriving in 1978 and 1980 had more experience of the latest avionics, computers and emerging technologies, and would be expected to fly multiple times, whereas those from the earlier groups who remained in the Office at the end of the decade were all in their forties and had over ten years of service at NASA. The long-term plan was to develop a cadre of new astronauts who would crew the majority of the Shuttle missions during the 1980s and early 1990s. [**6**]

ENTERPRISE TAKES CENTER STAGE

Most of the news of Shuttle activities during 1977 focused upon the ALT program conducted at Edwards AFB using the *Enterprise* orbiter, but in the background, several events affected the future availability of astronauts to crew the early Shuttle flights. Firstly, PJ Weitz was detailed to head up the Astronaut Office Shuttle Design Support Group. Then, on March 15, Ron Evans resigned from NASA to join the Western America Energy Group. Having completed his backup role for Apollo-Soyuz in 1975, Evans had been working on the operational aspects of the Shuttle ascent phase, primarily for STS-1 but also for follow-on missions. Two months later, on June 25, Jerry Carr resigned from NASA to join Bovey Engineers in Houston. On August 31, Jack Swigert became the third Group 5 astronaut to depart the agency in less than six months, leaving his position on the Committee on Science and Technology to enter politics. Additionally, Hank Hartsfield retired from the USAF with the rank of colonel but continued as a civilian astronaut with NASA, and Vance Brand was detailed to the astronaut selection board, assisting in choosing the first group of Shuttle astronauts. The new group of 35 was selected in December 1977, though they were not named until January 1978.

Shuttle flies… and glides to its first landings

The ALT test program was divided into four phases. The first was a series of taxi tests that never left the ground, with the unmanned orbiter bolted to the back of the modified and strengthened 747 to determine the structural integrity of the combination. The second was a series of unmanned inactive flights, in which the 747 carried the inert orbiter aloft, circled the airbase and then landed. This was a precursor to the role of the SCA over the next 35 years when the 747s ferried the orbiters across the country, for example on return flights from diverted missions, or flights from Florida to California for major upgrades. Thirdly, there were three captive flights, with a crew and activated onboard systems, and finally there were five fully-active free flights, where the orbiter was released from the carrier aircraft to make its own unpowered landing, with or without its protective aerodynamic tail cone attached. Those involving the astronauts are presented in Table 12.

The four astronauts occupied 16 flight seats on the eight test flights, logging a total of 17 hrs 7 mins inside *Enterprise* during both the manned captive flights and the time the orbiter was on top of the 747 prior to each free flight. The total free flight time logged by the four astronauts was 44 mins 12 secs. Fred Haise and Gordon Fullerton logged five flights (two captive and three free), accumulating 5 hrs 35 mins 43 secs inside *Enterprise* atop the SCA, and 14 mins 1 sec in free flight. Joe Engle and Dick Truly completed a single captive flight and two free flights, logging 2 hrs 57 mins 47 secs in captive flight and 8 mins 5 secs on free flight. Once the ALT program was completed, work focused on getting the Shuttle into space under the OFT program.

Table 12 SPACE SHUTTLE APPROACH AND LANDING TEST PROGRAM 1977 (OV-101 *Enterprise*)

MANNED CAPTIVE FLIGHTS

Flight	Date	CDR	PLT	Flight Time H:M:S	Capcom	Lead T-38 Chase Pilot
1	June 18	Haise	Fullerton	0:55:46	Overmyer	Bobko
2	June 28	Engle	Truly	1:02:00	Bobko	Overmyer
3	July 26	Haise	Fullerton	0:59:53	Overmyer	Bobko
Total time manned captive flights				2:57:39		

FREE FLIGHTS

Flight	Date	CDR	PLT	Total Flight Time H:M:S	Total Free Flight Time M:S	Separation Altitude Feet/Meters	Capcom	Lead T-38 Chase Pilot
1	Aug 12	Haise	Fullerton	0:53:51	5:22	24,100 ft./7,346 m	Overmyer	Bobko
2	Sep 13	Engle	Truly	0:56:10	5:31	26,000 ft./7,925 m	Bobko	Overmyer
3	Sep 23	Haise	Fullerton	0:50:36	5:34	24,700 ft./7,528 m	Overmyer	Bobko
4	Oct 12	Engle	Truly	1:07:42	2:34	22,400 ft./8,827 m	Bobko	Overmyer
5	Oct 26	Haise	Fullerton	1:55:37	2:05	19,000 ft./5,791 m	Overmyer	Bobko
Total time Free Flights				5:43:56	21:06			

ORBITAL FLIGHT TESTS

Bob Overmyer was one of a growing number of astronauts assigned to the Office's OFT missions group from the late 1970s. In 1979, Overmyer was assigned as the Office's Deputy Orbiter Manager, responsible for the final preparations of OV-102 *Columbia* at KSC leading up to STS-1. This assignment, which ended with the rollout of the orbiter to the launch pad in December 1980, included being the lead for the completion of manufacturing and application of the Thermal Protection System (tiles) on *Columbia* while at the Cape. Don Peterson became responsible for engineering support for man/machine interfaces and safety assessment for the series of test flights, while TK Mattingly was assigned as Technical Assistant for OFT in March 1978, responsible to the Manager of the OFT Program in the Shuttle Program Office. PJ Weitz participated in a series of underwater tests of Shuttle/Spacelab EVA operations and emergency procedures.

In August 1978, Bill Pogue suddenly resigned from NASA a second time to set up in private business in Tulsa, Oklahoma. Having returned to the Office from the ERPO in the spring of 1977, he began training to fly the Shuttle. One of his other commitments was to argue for keeping the Ascans in the Astronaut Office after they qualified, rather than see them farmed out to different offices across the JSC campus. Pogue's sudden resignation triggered some reports suggesting his departure was due to a delay in Shuttle flights, but in his 2011 memoir, Pogue explained the reason. In July 1977, suffering from a bad headache, he went to the flight medicine clinic for medication and had his blood pressure checked while there. The high readings revealed effectively grounded him, and he was told to look for another type of work if he wished to remain healthy. He decided to tender his resignation immediately, but Chief Astronaut John Young instead put him on a one-year leave of absence to see if the problem would clear up. When he returned to the Office after a year, he no longer felt the same enthusiasm as before, and decided that returning to serve as an astronaut was no longer for him. He resigned a second time, with little regret. [**7**]

Crewing for OFT

The 35 new astronauts of Group 8 were finally announced on January 16, 1978, and would report for Ascan training in July of that year. Their two-year program was completed in just one year, so a new cadre of NASA astronauts was soon waiting on the sidelines. As the 'Thirty-Five New Guys' completed their first technical assignments, they were ready to take over the mantle of flight crew members from the Apollo, Skylab and MOL veterans as the latter moved on to new challenges, but not before the Shuttle systems had been evaluated and (prematurely) declared 'operational.'

On March 16, 1978, two months after the new astronauts had been publicly named, NASA released the names of eight astronauts who were to conduct the OFT flights prior to operational service. Originally scheduled for six OFT missions, the series was subsequently trimmed to four, with the other objectives spread over several early missions. The OFT crews are shown in Table 13.

At this point, the OFT-3 and OFT-4 positions were not formal assignments, but the pairings did point to the crews for the third and fourth flights. It is known that Haise, Lousma, Brand and Fullerton did train as a four-person unit to support both the first two flights.

Table 13 SHUTTLE ORBITAL FLIGHT TEST CREWS MARCH 1978

Test Flight	Prime CDR	Prime PLT	BUp CDR	BUp PLT
OFT-1	Young	Crippen	Engle	Truly
OFT-2	Engle	Truly	*Haise*	*Lousma*
OFT-3	*Haise*	*Lousma*	*Brand*	*Fullerton*
OFT-4	*Brand*	*Fullerton*	None	None

OFT Crew announcement press conference. (L to R): Fullerton and Brand (the original OFT-4 crew), Lousma and Haise (OFT-3), Truly and Engle (OFT-2) and Crippen with Young (OFT-1).

Early exercises

Training for the OFT missions began soon after their assignments. The initial two-week orbiter crew station review took place between August 28 and September 8, 1978, in Building 9A at JSC. The review was designed to evaluate the crew compartment of the Shuttle orbiter, consisting of the flight deck and mid-deck, using the 1-G mockup. They practiced emergency egress through the overhead windows as well as the side hatch, while wearing the SR-71-derived pressure garments they would use for launch and entry during the OFT missions. They also evaluated other supplies and equipment, such as food, clothing, tools and cameras, reporting any problems they encountered and suggesting improvements for the future. At the end of the tests, Gordon Fullerton reported that nothing serious was found, "except that it's mockup equipment, [so the] only problem was that the equipment we're working with isn't real." One observer commented later that their activities were, "not bad for beginners. A few hundred more runs and they'll have it down pat." [8]

A variety of assignments

During 1979 and 1980, members of the Office completed a wide range of technical assignments supporting progress towards the first Shuttle launch. An example was given in a memo dated October 23, 1979 (CB-79-054), addressing the topic of the forthcoming OFT. The lead point of contact was PJ Weitz, who assumed Office responsibility for coordinating all technical efforts for OFT. Vance Brand and Gordo Fullerton were assigned Ascent/Abort Engineering Simulations and Ascent Flight Control issues. Hank Hartsfield supported the development of the orbiter entry flight control systems and associated interfaces, as well as the Backup Flight Control System (BFCS). The Configuration Control Board (CCB) and Technical Status Review (TSR) were the responsibility of Don Peterson (supported by Group 8 Ascan Guion Bluford), while EVA issues were the responsibility of Jack Lousma.

On January 8, 1979, the first Shuttle crews (Young/Crippen and Engle/Truly) began Shuttle Mission Simulator lessons in Building 5 at JSC. Each session simulated pre-launch ascent, entry, their response to malfunctions and their ability to carry out procedures to sustain orbiter functionality. The course lasted 8 hours, spread over several weeks across a nine-month period. In March of that year, training began in the 1-G trainer in Building 9A. This simulator prepared crews by familiarizing them with the crew quarters on the flight deck and mid-deck. The astronauts practiced habitation exercises across 15 sessions, preparing food, stowing equipment, operating cameras, and dealing with emergency procedures and other scenarios. [9]

On March 8, 1979, OV-102 *Columbia* followed *Enterprise* out of the Rockwell International production facility at Palmdale, although in order to meet the delivery date, many of the thermal protection tiles and some internal equipment were not installed. *Columbia* finally arrived at the Orbiter Processing Facility (OPF) 1 on March 24, 1979. The following day, the long process of adding the remaining equipment began. This would take 613 days in the OPF before the stacking and numerous systems checks for STS-1 could begin. To keep the Office up to speed on the delays and progress, Karol Bobko was assigned to the Test and Checkout Group at the Kennedy Space Center (KSC) in Florida, in preparation for the launch of STS-1. The assignment ended on April 12, 1981 with the successful launch of *Columbia* on its first mission.

Between December 1979 and April 1981, TK Mattingly was assigned as Head of the Astronaut Office Ascent/Entry Group, Space Shuttle Office at JSC. From 1978, Bruce McCandless participated with several other astronauts in underwater servicing techniques, primarily on the HST mockup in the Neutral Buoyancy Simulator at MSFC in Huntsville, developing techniques and timings from which servicing EVAs from the Shuttle could be developed for Hubble and other satellites. [10] In 1980, McCandless was assigned to the Astronaut Office On-Orbit Branch within the Shuttle Program Office, where he continued to be the point of contact for issues relating to the Inertial Upper Stage (IUS), MMU and Hubble. Later that year, McCandless was underwater once again, for more Hubble servicing techniques and EVA tests at MSFC. He was joined by several of the new class of astronauts, including 'Pinky' Nelson and Shannon Lucid. These were some of the many technical and managerial roles that members of Group 5 and 7 fulfilled in the six-year transition from Apollo in 1975 to the first orbital test flights in 1981.

Lousma's return to Skylab

Shortly after Haise and Lousma were named to the third OFT, a tentative plan was announced to return to Skylab and attach a Teleoperator Retrieval System (TRS). The TRS was a remotely controlled rocket stage intended to boost the unmanned station to a higher orbit, pending the possible resumption of crewed activities on later Shuttle flights. The crew would deploy the TRS using the Shuttle RMS and guide the device to an automated docking at the front port on the workshop. The station would then have been either boosted to a higher orbit pending its potential reuse, or deorbited to a safe re-entry over the Pacific Ocean. A final decision on the mission would be made following the latest orbital predictions the following year. During 1978, however, significant slips in the launch schedule of the first Shuttle mission and adverse predictions of Skylab's re-entry meant the re-boost mission concept was abandoned on December 19, 1978. America's only national space station re-entered the atmosphere and burned up on July 11, 1979. It would be sixteen years before another American visited a station – the Russian Mir complex – in orbit. By then, the last of the Apollo-era astronauts had long since retired.

Once it was clear that his Shuttle flight would not reach Skylab before the workshop re-entered the atmosphere, Fred Haise became the first member of the Office assigned to a Shuttle mission to leave the program, on June 29, 1979. He left NASA to join Grumman Aerospace Corporation in Bethpage, New York, where he had spent many hours preparing the LM to fly during his earlier years at NASA. His departure necessitated a change in OFT crewing. [11] Lousma was promoted to CDR for OFT-3 and Fullerton moved from PLT OFT-4 to the same role on OFT-3. Fullerton's PLT assignment on OFT-4 to accompany CDR Brand was eventually given to Bob Overmyer.

Beginning on May 29, 1980, several astronauts, including Karol Bobko, flew the first training runs of T-38 chase profiles for the initial landings of the orbiter from space at the Shuttle Landing Facility (SLF) in Florida. Flying three T-38s, the astronauts used one of the aircraft to simulate the orbiter gliding in while the other two acted as chase planes. Aside from practice for the pilots, these tests allowed prime and backup crews to become familiar with the KSC landing strip. The tests also continued the development of coordinated techniques between the aircraft pilots and the tracking personnel on the ground, as well as evaluating ways to reduce bird-strike hazards at the SLF area. [12]

STS-1 (April 12-14, 1981)

Flight crew: John W. Young (CDR), Robert L. CRIPPEN (PLT)
Backup crew: Joe H. ENGLE (CDR), Richard H. TRULY (PLT)
Spacecraft: Columbia (OV-102) 1st mission
Launch Vehicle: Space Shuttle ET/SRB/SSME
Objective: 1st Shuttle flight; 1st Orbital Flight Test (OFT-1) of Shuttle system
Duration: 2 days 6 hours 20 minutes 53 seconds
Support Assignments: MCC-Capcom HARTSFIELD (Bronze team)

After a delay of two days due to a glitch in the synchronization of the orbiter's computers, the first Shuttle mission blasted off on the 20th anniversary of the world's first spaceflight by Yuri Gagarin. This latest milestone in human spaceflight was also the first time a manned spacecraft had not been tested in orbit prior to supporting a human crew.

The planned two-day test flight was textbook, with only a few missing tiles raising concerns. Crippen finally became the first former MOL astronaut to make it into space and orbit the Earth, over a decade after he was originally scheduled to do so. Columbia's *payload bay was empty, apart from some test equipment, so Young and Crippen put the orbiter through a program of systems and procedural evaluations, as well as exploring its roomier, two-level crew compartment for habitability. A perfect landing at Edwards gave rise to premature reports of routine access to space and predictions of up to 50 flights a year. Nevertheless, it was a great start to the challenging and much-delayed program.*

On this first Shuttle mission, the majority of the support roles were filled by the Ascans from the 1978 selection. As with the Apollo era, it was deemed a useful assignment in preparing new astronauts (as well as veterans) for future flights or a pending move to managerial appointments. With most of the pre-1978 astronauts now retired, or involved in the OFT and early operational missions, the roles they had fulfilled during the Apollo years were now taken up by the next generation of astronauts.

Engle and Truly were officially named as the crew for the next flight, STS-2, on April 23, with Mattingly and Hartsfield as their backups. [**13**] The Mattingly/Hartsfield pairing was not part of the original OFT group named in 1978, but Young and Crippen had essentially been living in simulators for three years and needed some downtime following STS-1. George Abbey, the Director of Flight Crew Operations, recognized this and also knew that the training schedule could accommodate four two-man crews in the Shuttle simulator. He added Mattingly and Hartsfield to the pool which included Engle and Truly, Lousma and Fullerton, and Brand and Overmyer.

STS-2 (November 12-14, 1981)

Flight crew: Joe H. ENGLE (CDR), Richard H. TRULY (PLT)
Backup crew: Thomas K. MATTINGLY II (CDR), Henry W. Hartsfield, Jr. (PLT)
Spacecraft: Columbia (OV-102) 2nd mission
Launch Vehicle: Space Shuttle ET/SRB/SSME
Objective: 2nd Shuttle flight; 2nd Orbital Flight Test (OFT-2); 1st tests of RMS system
Duration: 2 days 6 hours 13 minutes 13 seconds

This mission recorded the first re-flight of a manned spacecraft with a crew on board (Gemini 2 had flown unmanned in 1965 and repeated the feat for the only MOL launch in 1966). Launch occurred on Truly's 44th birthday, 17 years after he was first chosen to train as a MOL astronaut. The mission also saw Engle finally make it to orbit, over 15 years after his selection to the NASA astronaut program and 16 years after his first 'astro-flight' in the X-15. This time a five-day flight was planned, but a problem with one of the three fuel cells curtailed the mission to just a two-day minimum mission. Despite this, the astronauts crammed as much as they could into the time they had on orbit. Their tasks included the first tests of the RMS, a Canadian-built robotic arm which became a crucial tool on many subsequent missions. There were some teething problems with the RMS, but the system generally performed well. Good data was also received from a multispectral imaging radiometer and the Shuttle Imaging Radar payload. Engle's planned mid-deck/airlock evaluation of EMU donning and doffing without opening the EVA hatch was cancelled due to the minimum mission situation and deferred to STS-4.

The pace of the program began picking up towards the end of the year, with the identification of three CDR/PLT combinations on November 30. [14] The STS-3 crew were identified as Lousma (CDR) and Fullerton (PLT), with Mattingly and Hartsfield continuing their backup role for the third mission before flying as prime for STS-4. In addition, Brand (CDR) and Overmyer (PLT) were identified in a preliminary assignment to STS-5.

[Top left] Crippen prepares a meal during STS-1. During STS-2, Engle [top right] exercises while Truly [bottom] reads a teleprinter message.

Between testing and operations

On March 2, 1982 NASA officially announced the next three crews (Group 5/7 in *italics*):

STS	CDR	PLT	MS1	MS2	Objectives
4	*Mattingly*	*Hartsfield*	None	None	OFT-4/DoD
5	*Brand*	*Overmyer*	Allen	Lenoir	Commercial satellites
6	*Weitz*	*Bobko*	Musgrave	*Peterson*	TDRS A

This was an interesting announcement, as it was originally expected that Brand and Overmyer would have been assigned to STS-4. But there was more to it than just assigning the most obvious crew to the last flight test. As early as 1979, the USAF had secured a Shuttle payload launch for June 1982, and for about 18 months this was manifested for either STS-18 or STS-20. But schedules slipped and the first launch was delayed into 1981, with completion of the fourth and final OFT mission now planned for June 1982. The USAF equipment was originally a classified imaging payload which used a HEXAGON-derived camera located on a pallet in the payload bay. This payload was scrapped towards the end of 1980 and replaced with a suite of payload bay experiments instead. But the USAF remained adamant about their June 1982 launch date, in order to gain experience of working with NASA and the Shuttle before committing to fully classified Department of Defense (DoD) payloads, and opted to fly on OFT-4/STS-4.

Brand and Overmyer could have been assigned to OFT-4/STS-4, given Brand's past military experience and with Overmyer being a former MOL astronaut, but George Abbey was convinced that Brand would be a good commander for the first four-person crew on STS-5. In addition, it was thought that Mattingly, a serving Naval officer, would be more acceptable to the military for the first DoD shuttle payload. Mattingly, to his credit, was also well known for his meticulous attention to detail, with nothing escaping his attention. He had been informed of the assignment as early as April 1981, as the payload would require a year's lead time to meet USAF requirements.

Interestingly, Brand recently stated that he was never told why he was reassigned to STS-5, "however, I was pleased because it was a more complex flight, involving a lot of flight testing, first shuttle satellite deployments, first (planned) EVA, first inclusion of MS on Shuttle, first operational flight, etc." [15]

Another significant comment in the March 2 announcement was that specific backup positions would no longer be assigned, for the first time in U.S. manned spaceflight history, since there was now an experienced pool of flight crew members. Any assigned crewmember could now be replaced, with only a minimal impact to crew training and mission scheduling. [16] However, it subsequently became clear that later crews did still perform 'support roles,' for missions with similar objectives, to assist in executing the earlier mission and in preparation for their own later flight. Another watershed was that these three crews would be the last ones solely composed of pre-1978 selection astronauts.

STS-3 (March 22 – 30, 1982)

Flight crew: Jack R. LOUSMA (CDR), Charles G. FULLERTON (PLT)
Backup crew: Thomas K. MATTINGLY II (CDR), Henry W. HARTSFIELD, Jr. (PLT)
Spacecraft: Columbia (OV-102) 3rd mission

Launch Vehicle: Space Shuttle ET/SRB/SSME
Objective: 3rd Shuttle flight; 3rd Orbital Flight Test (OFT-3); 1st Shuttle mission over 7 days
Duration: 8 days 0 hours 4 minutes 45 seconds

Four months after completing STS-2, Columbia *was back in orbit for the third time. For this mission, most of the onboard systems worked as planned, allowing a full eight-day mission to be flown. The longest flight of the orbiter to date, this represented the average mission duration planned for most of the Shuttle missions. This was a busy and hectic flight plan, centered on further tests of the orbiter and its systems and, for the two crewmembers, a mixture of test flying and science. The RMS was used to move, but not release, a payload above the cargo bay and there was also an extensive program of hot and cold soaks, exposing the surfaces of* Columbia *to temperatures between -66°C and +93°C. Other activities included a space science project, at the time considered a pioneering effort to gain a better understanding of how* Columbia *might be affected by certain elements in the environment in which she flew. There was also a series of medical and material processing experiments, the first of a series of student experiments flown on the Shuttle, and the pioneering GAS canister in the payload bay. The latter was the first of a long series of low-cost, small, self-contained experiments submitted by industry, schools, individuals and other institutions and organizations, to be flown on a space-available basis and taking advantage of the orbiter's cavernous payload bay and frequent flying capabilities. The landing occurred at White Sands in New Mexico, as the primary landing strip at Edwards was waterlogged after torrential rainstorms. Lousma over-corrected what he assumed was an excessive nose pitch-down rate from a higher than planned landing speed, causing the nose to suddenly rise as though* Columbia *wanted to take off again. But it was instantly corrected and the nose lowered as planned.* Columbia *touched down and rolled to a safe wheel stop. It had been a near-perfect mission and gave a boost of confidence for the program's future.*

In March 1982, Joe Engle was named Deputy Associate Administrator for the Office of Space Flight, Washington D.C., under former MOL astronaut James Abrahamson. Working in the STS office at NASA Headquarters, this temporary assignment utilized Engle's experience and would assist with the integration of Shuttle users while ensuring the maximum use of the Shuttle's manned capabilities. Assuming the position in April, Engle would retain his astronaut status and return to JSC at the end of the term to train for another flight. [17]

On April 20, 1982, NASA named the STS-7 crew and the flight deck crew for the STS-9 mission. Joining the two scientist astronauts named earlier as MS, the crews were confirmed by NASA as:

STS	CDR	PLT	MS1	MS2	Objectives
7	*Crippen*	Hauck	Fabian	Ride	Commercial satellites
9	Young	Shaw	(Garriott)	(Parker)	Spacelab 1

STS-9 became the first mission to be announced since Apollo 13 in 1969 whose crew did not contain a member of the 1966 or 1969 selection. The crew for STS-8 was named just four days later:

8	*Truly*	Brandenstein	Bluford	Gardner	TDRS-B

These assignments to STS-7 and STS-8 included the quick turnaround of veteran Group 7 astronauts Crippen and Truly, bringing their experiences of the early Shuttle missions to their second flights. Group 8 astronauts filled the rest of the announced positions. In December, medical doctors Norman Thagard (Group 8) and Bill Thornton (Group 6) were assigned to the crews of STS-7 and 8 respectively, to conduct studies into Space Adaptation Syndrome (SAS) on themselves and the rest of the crew. Truly had originally requested that Oceanographer Bob Stevenson be assigned at least one of the two flights. Since Gemini 12 in 1966, Stevenson had instructed every astronaut on the skills of oceanography from space and his assignment was soon approved, but recent incidents of SAS on the first Shuttle missions were causing concern. Some astronauts have found it tougher to adapt to space conditions than their colleagues, especially in the roomier Shuttle crew quarters. Early in the program, this had forced NASA to investigate the condition and its impact on crew performance quickly, and to establish remedies to lessen its effects. Stevenson was therefore reassigned (commonly known as 'bumped') to a later mission, but unfortunately never got the chance to fly at all, as each of the flights he was assigned to was either delayed or, following the loss of *Challenger* in 1986, cancelled. [18]

STS-4 (June 27 – July 4, 1982)

Flight crew: Thomas K. MATTINGLY II (CDR), Henry W. HARTSFIELD, Jr. (PLT)
Backup crew: None – 1st U.S. flight without a designated backup crew
Spacecraft: Columbia (OV-102) 4th mission
Launch Vehicle: Space Shuttle ET/SRB/SSME
Objective: 4th Shuttle flight; 4th OFT mission (OFT-4); 1st DoD classified payload
Duration: 7 days 1 hour 9 minutes 31 seconds
Support Assignments: A memo regarding the support roles on the forthcoming STS-4, dated May 20, 1982 and released a month before the flight, stated that both Truly and Crippen would be monitoring the flight at MCC-Houston and that the launch support team at KSC included Bobko serving as Weather (WX) coordinator.

The fourth and final OFT flight also carried the first military payload on the Shuttle, designated DoD-82-1 and later identified as the Cirrus cryogenic infrared experiment. For the first time on an American manned spaceflight, little detail of the mission or the activities of the crew was released because of this payload. The mission was not totally classified, however, so some information could be shared, but real-time data was sparse and restricted. In addition to the military payload, the crew occupied themselves with a full program of scientific experiments and engineering evaluations of the orbiter and its systems, including further tests with the RMS. Mattingly completed the simulation of EVA suiting and airlock procedures delayed from STS-2. He wore the new Shuttle EVA suit in the airlock but stopped short of opening the hatch, a task planned for the next flight. STS-4 completed the OFT program, with the STS system officially declared 'operational' from its next flight. In hindsight, this declaration after just four flights was a grave error by NASA. There remained much to understand about the Shuttle system, not only when the vehicle was in space, but also during its preparations for launch, its ascent and entry characteristics, and the time required to process hardware and service each orbiter between flights.

Life onboard the Shuttle. [Clockwise from top right]: Overmyer (STS-5) enjoys a meal, Fullerton (STS-3) in the pilot seat of *Columbia*, Weitz with Peterson (STS-6) discuss the flight documentation during a meal break, and Mattingly (STS-4) wrestles with TV equipment.

"WE DELIVER!" – THE ACE MOVING COMPANY

With the completion of the Orbital Flight Tests, the focus now shifted towards establishing the Shuttle's system and facilities for routine and reliable satellite delivery to orbit, while introducing new vehicles into the fleet and increasing the launch rate. Connected to this effort was a desire to identify the optimum turnaround time an astronaut might expect between flights, a subject addressed during in an interview with Bob Crippen shortly before the launch of STS-5.

Getting the crew ready to go again, and again?

In the October 1, 1982 issue of JSC *Roundup*, some eighteen months after STS-1, Bob Crippen was interviewed on the status of the Shuttle program as he prepared to fly his second mission (STS-7) the following year. [19] In the interview, Crippen was asked about the current status of the flight rate and astronaut turnaround for the Shuttle. The interviewer suggested to him that crew turnaround represented "two weeks of jubilation [in flying a mission], one week of debriefing, one day of rest, and several months of training for the next flight." Crippen replied that the crew rotation system was still a work in progress: "We're still finding out what that [turnaround rate] is. As the flight rate continues to increase, hopefully the turnaround time will end up being shorter. It's going to be something like two years [from STS-1 to STS-7] in my case. It's not obvious to us right now just how much time should be given to that interim period." Crippen was then asked if there was any biomedical consideration in determining how long the gap between flights should be. "No," he replied, "It's who can do it when, who's available, how much additional training, if any, is required. If I come back to fly another deploy mission, and we will be doing quite a few of them, I would imagine from my standpoint there would be very little difference. If I wasn't out of the training flow that long, it wouldn't take very long to get ready to go again."

When asked if it was part of the NASA philosophy to keep the time between flights as short as possible and whether a certain type of specialist was going to be introduced for specific flights, Crippen indicated both were indeed possibilities being looked at. He thought that six months between flights was good, perhaps slightly less, but training for a Shuttle flight was very demanding and to go straight back into training again might not be the best option without a vacation in between. He did agree that two years was too long, but that time for a crew to get to know each other and to work together as a team was important, so that when they came back for another flight, it would be easier to amend crew responsibilities, if necessary, for the new mission. As for generic crews, Crippen said, "I think it is quite possible that there will be general groups which tend to do deploy missions, others who will do Spacelab," with the caveat that at that point, it was too early in the program to start developing such groups. "Dick Truly and I were doing some planning for the Astronaut Office, on how, from an organizational standpoint, we are going to support this flight rate. It became very apparent that we can't do many of the things the Office has done in the past in supporting other facilities." Crippen also pointed out that by the end of 1983, they were expecting around 40 individuals to be actively in training for flights (with others in post-flight stages), plus some necessary overheads for other things outside of crewing that would tie up a significant amount of the Office at one time.

This suggested that regular astronaut recruitment would be needed to retain a suitable pool of crewmembers to fly the missions.

When asked about how many flights an astronaut might expect from a career flying the Shuttle, Crippen naturally had no idea. "Different individuals will be able to handle different amounts of flight. Twenty is an awful lot of flights. If you could turn around every six months, that would be about 10 years of flying, roughly. That could be a lot." Optimistically, he added, "We might be able to reduce that to every three months. That will probably be the key element; how long does it take to turn around? But I'll tell you that was so much fun, the first one. I'll stick around until they tell me I can't do it anymore."

That optimism from 1982 is very poignant over thirty years later, with the Shuttle no longer flying after 135 flights that struggled to keep to the flight manifest every year, and with nowhere near the expected flight rate of Shuttles or astronauts projected at the start of the program. After waiting almost 15 years to fly his first mission, and with the prospect of more Shuttle flights still on the horizon, it was no wonder that Crippen, like so many of his unflown former MOL colleagues and some of those who were still active from earlier groups, were hopeful of more frequent flights over the next few years. For a while, things did look promising, with Crippen being used as a 'frequent-flyer' pioneer to evaluate the minimum turnaround time between flights. Until a cold January day in 1986, when everything changed forever.

Best kept secrets

On October 20, 1982, JSC released the names of the first crew to fly a fully classified DoD mission. Interestingly, the command was given to TK Mattingly, who had previously flown as CDR STS-4, the partially classified final OFT mission. It was also announced that a fifth unidentified crewmember (later named as Gary Payton), from the USAF Manned Spaceflight Engineer (MSE) Corps, would be assigned to the flight at a date close to the launch. This was partly intended to retain the classified nature of the mission and payload, and the anonymity of the MSE members. [20]

STS	CDR	PLT	MS1	MS2	Objectives
10	*Mattingly*	Shriver	Onizuka	Buchli	DoD classified

STS-5 (November 11 – 16, 1982)

Flight crew: Vance D. BRAND (CDR), Robert F. OVERMYER (PLT), Joseph P. Allen (MS-1), William B. Lenoir (MS-2)
Spacecraft: Columbia (OV-102), 5th mission
Launch Vehicle: Space Shuttle ET/SRB/SSME
Objective: 5th Shuttle flight; 1st operational mission; commercial satellite deployments
Duration: 5 days 2 hours 14 minutes 26 seconds
Support Assignments: From a memo dated October 8, 1982, Crippen, Truly, and Hartsfield were listed as being assigned to support the flight from MCC in Houston, while McCandless would be located at Goddard Space Flight Center in Maryland.

For the first time, a four-person crew was launched into space, including the first Shuttle MS, who were both former scientist astronauts chosen with the 6th group in 1967. The payload of this first 'operational mission' included two commercial communication *satellites, which were successfully deployed from the payload bay. A planned demonstration EVA by the two MS, designed to evaluate the new spacesuit and EVA equipment, had to be postponed prior to opening the airlock hatch, after problems were discovered with both spacesuits. Helping the two MS prepare for their planned spacewalk, and in taking off the equipment after the excursion had been cancelled, was PLT Bob Overmyer. His designation as Intravehicular crewmember (IV) would be used on each subsequent flight for the member of the crew who aided the EVA crew in their pre- and post-EVA activities.*

A busy year

As 1983 dawned, it came with a busy manifest, as the 'operational side' of the Shuttle program geared up with two orbiters now in the rotation. On July 5, 1982, the day after *Columbia* landed at Edwards ending the STS-4 mission, the second orbiter, OV-099 *Challenger*, arrived at KSC on top of an SCA. Work was progressing well to deliver a third orbiter (OV-103 *Discovery*) by the summer of 1983.

As a result of this increased pace, four new crews were named in February, together with a partial crew assignment:

STS	CDR	PLT	MS1	MS2	MS3
11	*Brand*	Gibson, R.	McNair	Stewart	*McCandless*
Objectives: Commercial satellite deployment; MMU dress rehearsal for Solar Max					
12	*Hartsfield*	Coats	Mullane	Hawley	Resnik
Objectives: Commercial satellite deployment; Solar array tests					
13	*Crippen*	Scobee	Hart	Van Hoften	Nelson G.
Objectives: LDEF deployment; Solar Max retrieval, repair and redeploy					
18	*Overmyer*	Gregory F.	*Lind*	Thagard	Thornton W.
Objectives: Spacelab 3					
24			Henize		England
Objectives: Spacelab 2					

Of the 22 seats filled in these announcements, only three were to be occupied by Group 5 members, two of whom would fly as MS not pilots. A further three would be from Group 7. Of the remaining 16, three would be from the 1967 scientist astronaut selection and the rest from the new Group 8 class. Partial crew assignments were now being announced in stages, a system which became typical for the Shuttle crewing process, with Payload Specialist (PS) assignments announced later for STS-12, STS-18 and STS-24, together with the flight deck crew for STS-24.

STS-6 (April 4 – 9, 1983)

Flight crew: Paul J. WEITZ (CDR), Karol J. BOBKO (PLT), F. Story Musgrave (MS-1), Donald H. PETERSON (MS-2)
Spacecraft: Challenger (OV-099) 1st mission
Launch Vehicle: Space Shuttle ET/SRB/SSME
Objective: 6th Shuttle mission; maiden flight of *Challenger*; EVA demonstration and first deployment of TDRS satellite
Duration: 5 days 0 hours 23 minutes 42 seconds

The maiden flight of OV-099 Challenger, *the test vehicle converted to flight status, included the deployment of the first of a planned network of Tracking and Data Relay Satellites (TDRS), designed to improve round-the-clock coverage of future Shuttle missions. Don Peterson flew as MS-2 in the Flight Engineer (FE) position, assisting Weitz and Bobko during ascent and descent. The FE position had been introduced on the previous flight, STS-5, and had been evaluated by scientist astronaut Bill Lenoir during the ascent and Joe Allen for the descent. From STS-6, the position became the sole responsibility of the MS-2 astronaut, as part of the 'orbiter' or 'flight deck' team on a crew. Peterson also accompanied Story Musgrave on the maiden EVA from the Shuttle and the first US spacewalk for over nine years, since the last Skylab EVA in February 1974. During the 4 hrs 17 mins excursion on April 7, the two astronauts evaluated new EVA procedures, techniques and equipment, which would become standard on future missions. Peterson completed the only EVA to be conducted by a member of the seventh astronaut group, with all the others having flown as either PLT or CDR. Although Crippen, Truly, Fullerton and Hartsfield had completed contingency EVA training for OFT, they were not scheduled to perform a planned EVA from the Shuttle, a task normally assigned to MS. For STS-6, Bo Bobko served as IV astronaut.*

This mission saw the last of the astronauts who transferred from MOL in 1969 make their first space flights, with Peterson and Bobko flying together. The septet had waited between 15 and 17 years after the cancellation of MOL to finally enter orbit, but their dedication and resilience had clearly been worth it, being assigned to the first half-dozen missions of the program. Six of them were quickly reassigned as CDR for their next flight. In fact, by the time STS-6 had flown, most of those who flew on the first five missions were already in training for new flight assignments.

Unfortunately, problems with the IUS and TDRS deployed from STS-6 had a knock-on effect on future IUS missions, especially the military STS-10 mission. During the spring of 1983, Mattingly's crew was stood down temporarily, until they were officially reassigned to STS-15 and the planned STS-10 was scrapped.

STS-7 (June 18 – 24, 1983)

Flight crew: Robert L. CRIPPEN (CDR), Frederick H. Hauck (PLT), John M. Fabian (MS-1), Sally K. Ride (MS-2), Norman E. Thagard (MS-3)
Spacecraft: Challenger (OV-099) 2nd mission
Launch Vehicle: Space Shuttle ET/SRB/SSME
Objective: 7th Shuttle mission; Commercial satellite deployment mission; SAS medical investigations
Duration: 6 days 2 hours 23 minutes 59 seconds

Bob Crippen became the first of the Class of '69 to fly a second mission, and for the first time the veteran represented a minority in a crew as he was the only crewmember from the original pre-Shuttle selections. The other four crewmembers were from the first Shuttle-era selection of 1978, signaling a significant change in the makeup of American spaceflight missions. The emphasis of this mission was the deployment of another pair of communication satellites and further studies into the adaptation of humans to the conditions of spaceflight. The crew also deployed and retrieved a free-flying scientific satellite using the RMS, and demonstrated the onboard Ku-band rendezvous radar and retrieval techniques that were to become important elements of later Shuttle missions.

STS-8 (August 30 – September 5, 1983)

Flight crew: Richard H. TRULY (CDR), Daniel C. Brandenstein (PLT), Dale A. Gardner (MS-1), Guion S. Bluford (MS-2), William E. Thornton (MS-3)
Spacecraft: Challenger (OV-099), 3rd mission
Launch Vehicle: Space Shuttle ET/SRB/SSME
Objective: 8th Shuttle mission; satellite deployment; RMS load evaluation tests; SAS studies
Duration: 6 days 1 hour 8 minutes 43 seconds
Support Assignments: Support assignments for this mission featured some of the Class of '66 and '69, listed in a memo dated July 20, 1983. At Mission Control, Joe Engle was named Lead CB Representative, while Mattingly was assigned to Shuttle Mission Simulator (SMS) support. Public Affairs Office (PAO) support roles were filled by Bobko (as Lead) working with CNN and Lind with NBC. At the Cape, Crippen and John Young fulfilled KSC launch support roles as WX pilots.

This mission should have launched the second TDRS satellite, but delays with the on-orbit check of TDRS-1 bumped the TDRS payload to a later flight, leaving just a smaller Indian satellite to be deployed. There were further studies into SAS, as well as evaluations of the RMS by moving around a large mass in the form of the 7,448.2 lb. (3,383 kg) Payload Test Article (PTA). This mission is also remembered for the near burn-through of one of the SRB nozzles, which breached the 1.5 in (4 cm) limit to just 0.5 inch (1.3 cm). Post-flight investigations revealed that, had the nozzle burned through, a side-thrusting escape of gas exhaust would have sent Challenger *spinning out of control and probably resulted in crew fatalities. Fortunately, the crew knew nothing about their close brush with disaster, and this time NASA and the astronauts concerned were lucky to get away with just a near miss.*

Challenger had barely had time to cool down after its fiery reentry, when it was announced in Washington that Richard Truly had been named the head of the newly established U.S. Naval Space Command. The new position was designed to centralize the operational responsibility for several Naval space activities, and Truly commented: "For me it's an opportunity to continue my Naval career, which is something that I have never wanted to give up." The offer of the new post was made by the Chief of Naval Operations, Adm. James D. Watkins, *prior* to flying STS-8, but Truly only accepted on the condition that the appointment would not become effective (on October 1) until *after* he had flown that mission. In his statement, Truly said the decision to leave the astronaut program was a difficult one and he did not want to give an impression that he did not wish to remain at JSC any more, as he had thoroughly enjoyed his time there. He also stated that flying with his crew and commanding STS-8 gave him a "great thrill," but added that, "there comes a time in everyone's life that you have to make some tough decisions and so I decided to just take a different track for a time." [**21**]

On September 9, 1983, partly due slips in the launch dates, NASA changed the way future STS missions would be designated by introducing a confusing system. The new system ran from October 1 through September 30 each year, and would feature a three-digit coding system denoting (1) the fiscal year of planned launch using the last digit of that year (e.g., 1983/4 = 4, 1984/5 = 5), then (2) the launch site – 1 for launches from KSC in Florida and 2 for those from Vandenberg AFB, California – and finally (3) the launch sequence (A thru Z) planned within that fiscal year. In *theory*, this allowed for 26 launches from KSC and 26 from Vandenberg, totaling 52 missions each year. The numerical system tracked each assigned payload, not the crew or vehicle used, and could – indeed did – fall out of sequence, further confusing the picture. It would have been far easier to assign the next flight number once the vehicle had left the launch pad, but NASA decided against that option. Although this method effectively started from October 1, 1983, the first mission that used the system was the tenth Shuttle mission, formerly STS-11 but now STS-41B, in February 1984. The next mission to fly after the change was announced was STS-9, whose designation was not changed for some reason, even though some documentation did list the flight as 41A. This complicated system was used until 1986 and the 25th Shuttle mission, the tragic last flight of *Challenger*/STS-51L. With the Return-to-Flight mission, this coding was thankfully abandoned, reverting to the next flight number, STS-26, and restoring the previous numerical sequencing. Even so, missions did not always fly in numerical order.

On September 21, 1983, [22] NASA announced that Bo Bobko had been assigned as commander of STS-41E (previously STS-14)

STS	CDR	PLT	MS1	MS2	MS3
41E	*Bobko*	Williams	Seddon	Griggs	Hoffman
Objectives: Commercial satellite deployment					

The following month, on October 1, Jack Lousma became the first Shuttle-experienced astronaut to resign from NASA. He also retired from the U.S. Marines to follow his intention to run for political office in his home state of Michigan. [23]

On November 17, NASA announced several crew and mission changes, as well as new crewing appointments. [24] The news release also indicated that, due to payload availability, the crew commanded by Bobko had been reassigned from STS-41E to STS-41F, swapping assignment with Mattingly's DoD crew. The four new crew announcements again featured veteran members of Groups 5 and 7.

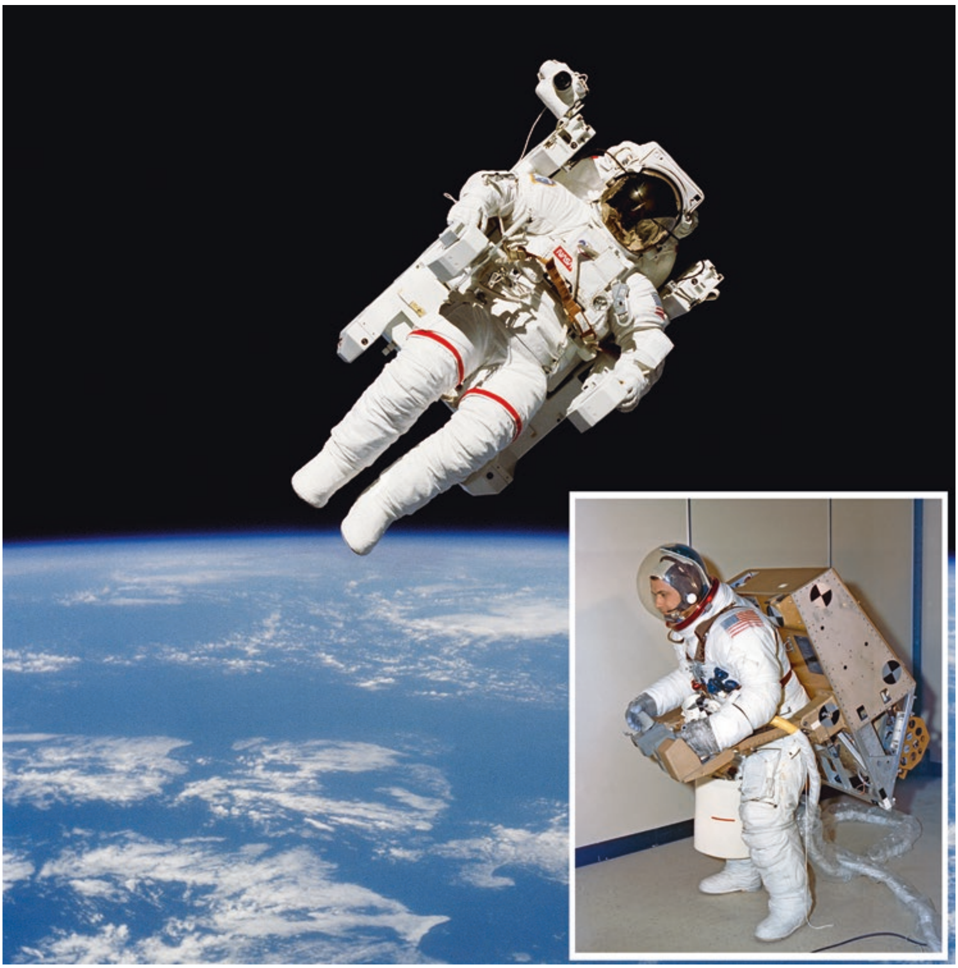
STS	CDR	PLT	MS1	MS2	MS3
Changes to previous crews:					
41E	*Mattingly*	Shriver	Onizuka	Buchli	DoD classified
(formerly STS-10, then STS-15/41F)					
41F	*Bobko*	Williams	Seddon	Griggs	Hoffman
Objectives: Commercial satellite deployment (formerly STS-14/41E)					
New crewing assignments:					
41G	*Crippen*	McBride	Sullivan	Ride	Leestma
Objectives: OSTA-3; ERBS; satellite refueling demonstration					
51F	*Fullerton*	Griggs	Henize	Musgrave	England
Objective: Spacelab 2					
51C	*Engle*	Covey	Buchli	Lounge	Fisher W.
Objectives: TDRS B or C					

In addition, a 5-person minimum "DoD Launch Ready Standby" crew was named as

DoD	*Bobko*	Grabe	Hilmers	Stewart	Mullane

The ‘DoD standby’ crew was to be flight ready for assignment to a military mission at short notice to fulfill the launch requirements. Though it was not confirmed, the launch standby crew would be evaluating the ability of a minimum crew of four to maintain flight proficiency over a period of time and be ready to launch at short notice. Crippen’s assignment was interesting, as he had yet to fly STS-41C, suggesting a further evaluation of the optimum turnaround time between launches.

STS-9 was the next Shuttle mission launched, on November 28, 1983, carrying the European Spacelab 1 payload. Though it featured the first (‘temporary’) PS on a crew, one from America and one from Europe, it also became the first mission since Apollo 12, fourteen years and seventeen missions earlier, to leave the launch pad without a member of either the 1966 or 1969 selections on board.



McCandless during the first untethered flights of the MMU, STS-41B. [Inset] McCandless models the MMU.

STS-41B (February 3 – 11, 1984)

Flight crew: Vance D. BRAND (CDR), Robert L. Gibson (PLT), Ronald E. McNair (MS-1), Robert L. Stewart (MS-2), Bruce McCANDLESS II (MS-3)
Spacecraft: Challenger (OV-099) 4th mission
Launch Vehicle: Space Shuttle ET/SRB/SSME
Objective: 10th Shuttle mission, commercial satellite deployment mission; 1st tests of MMU
Duration: 7 days 23 hours 15 minutes 55 seconds
Support Assignments: A memo dated January 6, 1984 listed three Group 5 astronauts in 41B support roles. Under MCC Support, Joe Engle was named the Lead CB Representative and TK Mattingly was assigned SMS Support. For KSC launch support, PJ Weitz was assigned alongside John Young as the WX pilots, a role the two men would fulfill for the next fifteen missions over a two-year period.

The two commercial satellites were deployed as planned, but the PAM upper stages both failed to operate successfully, stranding the two satellites in inoperable orbits. The satellites were later retrieved and returned to Earth on STS-51A in November 1984. Both were refurbished and launched on expendable launch vehicles in 1990. The highlight of the 41B mission was the first untethered EVAs, with Bruce McCandless and Bob Stewart both flying the MMU which McCandless had helped to develop since his support work on Skylab. On February 7, the two astronauts completed a 5 hr 55 min EVA, during which McCandless became the first to fly untethered using the MMU (Unit #3) out to 328 ft. (100m) from Challenger*, giving him the distinction of becoming the first human 'satellite.' A second EVA, on February 9, lasted 6 hrs 17 min and was restricted to test-flying both the second and third MMU units within the confines of the open payload bay. These flights were very successful in proving the MMU systems, which McCandless likened to flying a helicopter at Mach 25 (17,500 mph). In total, McCandless logged 3 hrs 17 min flying the MMUs across the two EVAs (47 min flying Unit #2 and 2 hrs 30 min on Unit #3). These two EVAs would be the last conducted by a member of the 1966 or 1969 classes. Another first was accomplished by mission CDR Vance Brand, assisted by PLT Hoot Gibson, who guided* Challenger *to the first landing of a returning Shuttle at the SLF at KSC. This was the first time a spacecraft, having completed its mission, had landed back at the site from which it had launched.*

Shortly after *Challenger* returned from the 41B mission, further delays in qualifying the IUS for a second flight meant that TK Mattingly's DoD crew were stood down again, pending yet another reassignment "at the earliest payload opportunity" to a DoD mission. Then, in the spring of 1984, Mission 41H (formerly STS-16, commanded by Rick Hauck) was cancelled and the crew were moved to STS-41G. As a result, Bobko's standby crew readied themselves to fly the former STS-41H mission to deploy a Satellite Data Systems QUASAR relay satellite. In late April, that mission was also cancelled, forcing the standby crew to step down pending yet another reassignment. Keeping track of crew assignments was becoming increasingly difficult, certainly not as straightforward as the Apollo days and its structured system of crew rotation. The nature of the Shuttle program and its variety of missions and payloads prevented such a system being adopted.

STS-41C (April 6 – 13, 1984)

Flight crew: Robert L. CRIPPEN (CDR), F. Richard Scobee (PLT), Terry J. Hart (MS-1) George D. Nelson (MS-2), James D. A. Van Hoften (MS-3)
Spacecraft: Challenger (OV-099), 5th mission
Launch Vehicle: Space Shuttle ET/SRB/SSME
Objective: 11th Shuttle mission; deployment of LDEF; repair and re-deployment Solar Max
Duration: 6 days 23 hours 40 minutes 7 seconds
Support Assignments: A March 13, 1984 memo listed Group 5/7 support for this mission as: MCC support: MOCR Representative – Engle (Lead) with McCandless and Peterson; SMS Support – Mattingly; KSC WX and landing support pilots – Weitz with Young; PAO support (Lead) – Overmyer working with NBS

This mission featured the deployment of the Long Duration Exposure Facility (LDEF), a 12-sided cylinder with 57 materials experiments mounted on and inside it. One of these was a collaborative experiment (A0038) between Don Lind at JSC and Johannes Geiss and Fritz Bühler of the University of Bern in Switzerland, which was designed to capture interstellar gas particles on four trays on the space-facing end of LDEF. [25] *The LDEF was scheduled for retrieval in 1985 after just one year's exposure, but was not returned until 1990 (STS-32). The EVA crew of Nelson and Van Hoften completed two EVAs, designed to support the retrieval, repair and servicing, and redeployment of the Solar Maximum (or Solar Max) science satellite, which had been suffering from an onboard systems failure since its launch in 1980. This mission finally demonstrated the capability of the Shuttle to rendezvous with, retrieve, service and redeploy a faulty satellite, a task that the program would achieve several times during the Shuttle's 30-year career. Following the mission, Crippen acquired the label "*Mr. Shuttle*" from the media, as he headed straight back to the simulator to train for his next mission (41G), his fourth in less than four years.*

In May, NASA finally reported that they were planning to retain STS crews as intact units for future missions as the expected flight rate increased. Assigning several crews at the same time would obviously put a strain on the limited training resources, so adopting this type of preparation would be sensible, cutting down training hours, the time it took for a new crew to gel into a cohesive working unit, and the number of crews in the training cycle. It was stated that Bob Crippen was being used as a test case for evaluating the shortest time needed for ascent and descent training, based upon his experience of his first three missions and his assignment to fly a fourth, just six months after returning from his third flight. Previously, astronauts had been assigned to Shuttle missions on an individual basis.

A summer of delays and change

On June 8, Vance Brand was named as CDR of the STS-51H crew [26], which was manifested to fly the first Earth Observation Mission payload (which eventually became ATLAS-1)

STS	CDR	PLT	MS1	MS2	MS3
51H	*Brand*	Smith M.	Springer	Garriott	Nicollier (ESA)
Objectives: Earth Observation Mission (EOM) 1					

Less than three weeks later, a pad abort on June 26 delayed the maiden launch of *Discover*y for over two months. One consequence of this was that, on July 12, NASA cancelled STS-41F (commanded by Bobko), a similar satellite deployment mission, and elected to combine the two missions. Both the Hartsfield and Bobko crews were placed on extended leave until the new mission was re-manifested. The new flight crew manifest was announced by NASA on August 3 [27] and saw a whole series of changes over the next few months.

The Hartsfield crew would now fly the re-manifested 41D/41F combination, now identified as just STS-41D, deploying three commercial satellites on the same mission for the first time.

Bobko's former 41F crew was reassigned to 51E to deploy TDRS B. They were joined by French PS Patrick Baudry. The military 41E mission under the command of TK Mattingly was cancelled yet again and the crew reassigned to STS-51C, which would include an MSE (though the formal announcement of Gary Payton was not made at this time). This would be Mattingly's last mission, when it finally left the launch pad, as it had already been announced that he would leave NASA after 51C in 1985 and return to the U.S. Navy, as commander of the USN Electronic Systems Command in Washington, D.C. [28]

Joe Engle's STS-51C crew was moved to STS-51G and would deploy more Comsats. Bobko's 'DoD standby crew' was now assigned to STS-51J, a defined classified mission. Hank Hartsfield, scheduled to command *Discovery* on its first mission later that month on STS-41D, was named to STS-61A, the first German-dedicated Spacelab mission (Spacelab D-1), formerly manifested as STS-51K. The astronauts who had previously been named to 51K were now switched to fly on STS-61A

Though not acknowledged at the time, there was some uncertainly about the payload that STS-51J would be carrying for the October 1985 launch slot which required the 'DoD standby crew.' Options included a QUASAR relay satellite, a TEAL RUBY/CIRRIS, or DSCS. Because of the indecision, the core NASA crew had to be familiar with all possibilities and payloads, involving a year of extensive and varied payload training.

STS-41D (August 30 – September 5, 1984)

Flight crew: Henry W. HARTSFIELD, Jr. (CDR), Michael L. Coats (PLT), Richard M. Mullane (MS-1), Steven A. Hawley (MS-2), Judith A. Resnik (MS-3), Charles D. Walker (PS-1, McDonnell Douglas)
Spacecraft: Discovery (OV-103); 1st mission
Launch Vehicle: Space Shuttle ET/SRB/SSME
Objective: 12th Shuttle flight; maiden flight of Discovery; satellite deployment mission
Duration: 6 days 0 hours 56 minutes 4 seconds
Support Assignments: A May 23, 1984 memo lists support by Group 5 and 7 astronauts for the *original* 41D mission as: MCC support: Brand, one of four astronauts assigned to SPAN; SMS support: Overmyer; KSC WX and landing support pilots: Weitz with Young; ELP WX T-38 Engle; PAO support: Mattingly, assigned to CNN.

Once on orbit, the three large communication satellites were successfully deployed, and PS Charlie Walker operated the McDonnell Douglas Continuous Flow Electrophoresis

System (CFES) on the mid-deck. The CFES was designed to investigate the potential for a commercial pharmaceutical space processing industry. The crew also extended a 102 ft. (31m) solar array which was unfurled high above the payload bay, the longest structure deployed in space to date. It generated 250 watts of additional electrical power via the Shuttle Power Extension Package prototype, part of an evaluation into supplementary power systems to extend future Shuttle flights beyond 10-12 days. The crew earned the nickname ‘Ice-Busters,’ in parody of the ‘Ghostbusters’ movie popular at the time, when they used the end of the RMS to dislodge a large chunk of ice that had built up from venting excess water from the fuel cells.

Remembering Hank Hartsfield.

Former STS-41D Mission Specialist Steve Hawley remembered his first commander as “a skilled pilot, an outstanding representative of both the USAF and space program and, primarily, a proud American.” [29] Hawley also remembered that Hartsfield was “a story teller, loved a good joke, and was also known in the Astronaut Office for being quite outspoken in his opinions, particularly when they concerned politics. Hank was burdened with command of a crew of rookies. On the other hand, we were blessed with a commander who watched out for us and valued our opinions and contributions to the crew and mission.

“Our crew included the first commercial Payload Specialist and the second American woman to fly in space. A southern gentleman, Hank was as protective of Judy Resnik as he would have been of his own daughters. He was welcoming to Charlie Walker and made him feel truly a part of the crew. I think that Hank was a father figure to all of us. I’m sure that he felt like he was, at times, herding cats and the training team fondly referred to us as the ‘Zoo Crew.’ Hank managed to keep the crew in good spirits through a number of delays in the launch schedule. The delays were the result of changes in payloads, as well as the delay caused by the first Shuttle on-pad abort. When the main engines unexpectedly shut down right before T-0, Hank was calm as he led us through the immediate action procedures that we had practiced in the simulator for just this case. When we finally launched two months later, we encountered another unique problem after a few days on orbit. We formed an ice cycle on the dump valve during a waste water dump. For safety reasons, we had to remove the ice prior to entry. Hank assumed the responsibility for executing the procedure developed by Mission Control to knock the ice off the Orbiter with the robot arm. This was a challenging task, because it involved maneuvering the arm in an area where it wasn’t visible from the crew module. One other on-orbit event highlights Hank’s concern for his crew. During the mission, we had a call from President Reagan and it might have been the first time that everyone on a Shuttle crew had a chance to talk during a ‘VIP call’. It was a priority for Hank that each member of the crew, not just the commander, had a chance to talk with the president, even though it was difficult to fit us all in during the time we had available. Hank passed away about a month prior to the 30th anniversary of the mission. Three of us from Hank’s first command did a public event marking the anniversary and shared many other memories of Hank and our time together training for and flying 41D. We had lost our father figure and we all missed him very much.”

The latest 'new manifest'

In September, NASA released yet another 'new' manifest, listing the previously named crews to new mission designations and the PS assigned to the flight. Nine of the crews still featured a CDR from either the 1966 or 1969 astronauts, and one also carried a member of the 1966 selection as MS.

STS	Commander	Mission Specialists	Objectives
41G	*Crippen*		OSTA-3, ERBS
51C	*Mattingly*		DoD
51B	*Overmyer*	*Lind*	Spacelab 3
51E	*Bobko*		Commercial satellite deployment
51F	*Fullerton*		Spacelab 2
51G	*Engle*		Commercial satellite deployment
51J	*Bobko*		DoD
61A	*Hartsfield*		Spacelab D1
51H	*Brand*		EOM-1

Don Lind's first flight crew assignment had finally arrived, eighteen years after being chosen for spaceflight training, though he had been working on the Spacelab 3 payload for years prior to his assignment to the crew.

STS-41G (October 4 – 13, 1984)

Flight crew: Robert L. CRIPPEN (CDR), Jon A. McBride (PLT), Sally K. Ride (MS-1), Kathryn D. Sullivan (MS-2), David C. Leestma (MS-3), Paul D. Scully-Power (PS-1, USN Oceanographer), Marc Garneau, (PS-2, Canadian)
Spacecraft: Challenger (OV-099) 6th mission
Launch Vehicle: Space Shuttle ET/SRB/SSME
Objective: 13th Shuttle flight; Satellite deployment mission; Space Imaging Radar experiments; satellite refueling demonstrations
Duration: 8 days 5 hours 23 minutes 38 seconds
Support Assignments: A memo dated September 10, 1984 lists Group 5/7 support roles on 41G as: KSC WX and landing support pilots: Weitz with Young; ELP WX T-38: Engle.

Having waited in vain for three years to fly on MOL, then a further 12 years for his first flight as a NASA astronaut, Bob Crippen became the first astronaut to fly on four Shuttle missions, in just three-and-a-half years. STS-41G deployed the Earth Radiation Budget Experiment (ERBE) satellite, operated the Space Imaging Radar experiments and included an EVA by two of the MS, demonstrating the potential for satellite refueling capabilities on future satellite servicing operations. The PS operated a suite of ten Canadian experiments and conducted real-time observations of ocean phenomena from orbit. It was revealed after the mission that the flight could have ended in disaster, when over 4,000 heat-shield tiles were found to have worked loose after their adhesive had been weakened by a new waterproofing injection system applied during pre-launch processing. Once again, luck had played a role in the safe return of the orbiter and her crew. On both occasions, it had been Challenger *that had been close to disaster.*

Two days after Crippen landed *Challenger* at the end of STS-41G, he assumed a new role as Deputy Director, Flight Crew Operations [30], serving as a deputy to George W.S. Abbey while retaining his astronaut status. Later that month, Crippen was identified as CDR for STS-62A, the historic first Shuttle launch from the Vandenberg AFB in California.

The next mission, STS-51A, which launched on November 8, was crewed by members of the sixth and eighth astronaut selection, though some support roles were fulfilled by members of the Classes of '66 and '69, as revealed in a memo dated October 15, 1984. Those support assignments included: MCC support – Fullerton (SMS support); KSC WX and Landing support pilots – Weitz with Young; WX Alternate Ex T-38 – Engle; Lead PAO support – Brand (assigned to NBC).

Towards the end of the year, Don Peterson became the first of the Group 7 astronauts to depart the Office and resign from NASA, to become an independent aerospace consultant in the Houston area. [31] Fully able to fly as PLT or CDR, Peterson had not received a second flight assignment since flying as MS on STS-6 over eighteen months previously, unlike the rest of his selection.

A busy year – the calm before the storm

On January 29, 1985, Vance Brand was named as CDR for STS-61D/Spacelab 4 [32], together with PLT Dave Griggs. They joined the previously named MS.

STS-51C (January 24 – 27, 1985)

Flight crew: Thomas K. MATTINGLY II (CDR), Loren J. Shriver (PLT), Ellison S. Onizuka (MS-1), James F. Buchli (MS-2), Gary E. Payton (PS-1, USAF MSE)
Spacecraft: Discovery (OV-103), 3rd mission
Launch Vehicle: Space Shuttle ET/SRB/SSME
Objective: 15th Shuttle flight; 1st classified DoD Shuttle mission
Duration: 3 days 1 hour 23 minutes 23 seconds
Support Assignments: A memo dated January 3, 1985 listed Group 5/7 support roles on 51C as: MCC Support SPAN Rep: Engle; KSC WX and landing support pilots: Weitz with Young; Family escort duties: Hartsfield, with Brewster Shaw.

This flight, delayed a year by problems with the IUS, and then another day by the coldest weather in memory at KSC, became the first of ten classified, dedicated Shuttle DoD missions. It was also the first of only two flights to include a USAF MSE, the new generation of military astronauts who, from the late 1970s, had replaced the MOL cadre. The classified satellite deployed on an IUS was an ORION ELINT (electronic signals intelligence satellite). Very little was reported on this flight, recalling the secrecy that surrounded MOL, as well as earlier Soviet missions to the military-orientated Salyut 3 in 1974 and Salyut 5 in 1976/77. These stations were officially designated Almaz (Diamond) but were hidden behind the Salyut name to mask their real purpose from the West (though not to any great effect).

On January 29, the missions planned for the latter half of 1985 were confirmed, together with their crews. In this announcement, Vance Brand was listed as CDR for STS-61D/Spacelab 4, the first Space Life Science (SLS) mission, while still assigned as CDR for the EOM-1 mission. This was to be the first of several mission changes Brand endured between 1985 and 1988, with the cancellation of the STS-51H/EOM-1 mission, his reassignment to 61K/EOM-1, then reassignment from STS-61D/SLS-1, and eventually to STS-35 Astro 1.

The First Vandenberg Crew confirmed

On February 15, 1985, NASA confirmed the crewing for two classified missions: STS-62A, the first mission to be launched from Space Launch Complex 6 ('Slick-6') at Vandenberg AFB; and STS-51J out of KSC. [33]

STS	CDR	PLT	MS1	MS2	MS3	Objectives
62A	*Crippen*	Gardner G.	Mullane	Ross	Gardner D.	DoD
51J	*Bobko*	Grabe	Hilmers	Stewart		DoD

MSEs were to be named later to both missions. With the unannounced change of payloads, Mullane was reassigned from Bobko's crew to that of Crippen.

The saga of STS-51D

When the Shuttle manifests were originally developed, it all looked fine on paper, and for a couple of years the missions worked out well. But during 1983 and 1984, things began to go a little awry. The problem with flying a fleet of orbiters, with a variety of payloads, and all being processed or flown at the same time, lay in the logistics of the system. If one payload, item of hardware or mission was delayed, it often had a serious knock-on effect for the rest of the manifest. This meant that missions quite often did not fly on time or in sequence throughout most of the program. This was a nightmare not only to those who planned the missions and processed the hardware, but also for those who flew them, giving rise to the Office 'lore' of: "Don't fall in love with your orbiter; don't fall in love with your crew or mission – it's prone to change." As missions slipped and payloads were delayed, the crewing of missions became confusing. This was not the case in the Gemini and Apollo programs, when a set number of missions were known and the crews – with a few exceptions – had a fair chance of flying the mission to which they had been assigned. Until 1975, NASA's crewing philosophy was quite straightforward, but that all changed with the advent of the Shuttle.

A good example of the problem was STS-51D, in the spring of 1985. Ongoing issues with the TDRS system resulted in the decision to cancel the 51E mission commanded by Bobko on March 1, further delaying the launch of a second TDRS. Once again, two payloads would be combined into one flight, to be flown by Bobko's crew, bumping the originally assigned Brandenstein crew to STS-51G and Engle's crew down to STS-51I. This further delay in launching the second TDRS meant changing the original payload intended for the military STS-51J mission, also commanded by Bobko. That payload was to have been a CRYSTAL Keyhole 11 satellite, but without two operational TDRS satellites in orbit, the KH-11 would not have operated correctly. It was therefore removed from STS-51J and replaced by two DSCS payloads.

On March 6, NASA announced the new crew for STS-51D, now assigned to *Discovery* instead of *Challenger* due to the cancellation of STS-51E [34]

STS	CDR	PLT	MS1	MS2	MS3
51D	*Bobko*	Williams	Seddon	Griggs	Hoffman
Objectives: Commercial satellite deployment					

Two PS, Charles Walker of McDonnell Douglas and Senator Jake Garn, were also assigned. Garn's busy political schedule and direct involvement with the assigned mid-deck experiments moved from 51E to 51D secured his seat, while Walker's CFES equipment was already installed on *Discovery*'s mid-deck before the change. With the launch imminent and a timetable too tight to reconfigure the mid-deck, Walker's seat on 51D was also secure. The French PS for 51D, Patrick Baudry from CNES, was reassigned to 51G with the Brandenstein crew, as that flight offered a longer mission (7 instead of 4 days) and had more room for the Frenchman's equipment. With Walker's CFES unit already aboard *Discovery*, adding Baudry's equipment as well (which required a minimum of five mid-deck lockers), would have left insufficient locker space available when all the NASA equipment and supplies were installed.

A key factor in the reassignment and prioritization of Bobko to 51D was the need to preserve both the flight schedule for 1985 and the crew training program, with at least ten crews in different stages of training. It was also imperative to fly Bobko as soon as possible to capitalize on his training for the satellite deployment mission, while still preserving his schedule and training to fly the classified 51J mission six months later, using a similar turnaround profile to the one Crippen had set between STS-41C and 41G the year before.

On March 25, another 'new' manifest was released reflecting these and other changes. The missions assigned to Group 5 and 7 astronauts in that manifest were:

STS	CDR	MS	Objectives
51D	*Bobko*		Satellite deployment
51B	*Overmyer*	*Lind*	Spacelab 3
51F	*Fullerton*		Spacelab 2
51I	*Engle*		Satellite deployment
51J	*Bobko*		DoD
61A	*Hartsfield*		Spacelab D1
61D	*Brand*		Spacelab 4
61K	*Brand*		EOM-1

There was also a slim possibility of flying a revised (R) mission, inserted somewhere between May and September 1985, to deploy the much delayed TDRS-B/IUS prior to the Spacelab D1 mission that October, in order to improve communications for the later mission. Designated STS-51E (R), the suggestion was to have a three-person crew, namely Vance Brand (CDR), Dave Griggs (PLT) and Rhea Seddon (MS2/FE) fly the mission. But the option was not taken up and any reference to STS-51E (R) was quietly removed from the manifest.

A crew to deploy Hubble

On April 5, NASA named the MS to STS-51J, scheduled to deploy Hubble, as Bruce McCandless (MS-1), Steve Hawley (MS-2) and Kathryn Sullivan (MS-3). This trio fulfilled the need to assign an experienced crew to the important deployment mission and have an EVA crew with spacewalking experience. Sullivan had performed an EVA on STS-41G and McCandless on 41B, and he had worked for years on HST EVA issues as part of his CB technical assignments.

STS-51D (April 12-19, 1985)

Flight crew: Karol J. BOBKO (CDR), Donald E. Williams (PLT), S. David Griggs (MS-1), Jeffrey A. Hoffman (MS-2), M. Rhea Seddon (MS-3), E. Jacob Garn, (PS-1, U.S. Senator), Charles D. Walker (PS-2, McDonnell Douglas)
Spacecraft: Discovery (OV-103), 4th mission
Launch Vehicle: Space Shuttle ET/SRB/SSME
Objective: 16th Shuttle flight; satellite deployment mission
Duration: 6 days 23 hours 55 minutes 23 seconds
Support Assignments: A memo dated January 31, 1985 gave a combined STS-51E/D support assignment list (still unclear as to which mission would fly). Group 5 astronaut assignments were: KSC WX and landing support pilots: Weitz with Young; WX Alternate (T-38): Engle; PAO Support Lead: McCandless (working with ABC).

Two satellites were deployed, though the second did not activate as planned. This resulted in an unplanned EVA by the crew to attach trip devices on the end of the RMS in an attempt to snag the satellite's trigger and activate the spin-up and antenna deployment sequence. Unfortunately, despite a valiant effort by the crew, these attempts did not work. After the mission, a full EVA repair task was added to the STS-51I mission later that year. During the landing of 51D, Discovery's *brakes were damaged as Bobko tried to compensate for high crosswinds, and though a tire burst, the orbiter safely rolled to a wheel stop end of the mission.*

Lind in Spacelab 3, after waiting 19 years since selection to fly his first mission (STS-51B).

STS-51B (April 29 – May 6, 1985)

Flight crew: Robert F. OVERMYER (CDR), Frederick D. Gregory (PLT), Don L. LIND (MS-1), Norman E. Thagard (MS-2), William E. Thornton (MS-3), Taylor G. Wang (PS-1), Lodewijk van den Berg (PS-2)
Spacecraft: Challenger (OV-099) 7th mission
Launch Vehicle: Space Shuttle ET/SRB/SSME
Objective: 17th Shuttle flight; Spacelab 3 research program
Duration: 7 days 0 hours 8 minutes 46 seconds

This flight carried the Spacelab long module on its second outing and was manifested as Spacelab 3, a five-discipline mission covering materials and life sciences, fluid mechanics, atmospheric physics and astronomy. This mission was considered to be the first operational mission of the Spacelab series, although Spacelab 2, a pallet-only development flight, had yet to fly. Working two 12-hour shifts, Overmyer headed the Gold team comprising Lind, Thornton and Wang, while Gregory headed up the Silver team of Thagard and van den Berg. This arrangement yielded the maximum return from the one-week mission, effectively obtaining almost 14 working days of data. One of the challenges on the mission came from the operational performance of the Animal Holding Facility which leaked animal feces into the crew compartment, much to the annoyance of the flight crew.

Bob Overmyer said he and Bill Thornton were far from impressed: "We'd had real serious concerns prior to the flight that those cages were going to leak… we could not convince the ground personnel – the engineers and designers – that there were going to be problems. Remember that Bill Thornton and I had both been in orbit before, and we both looked at the cages and were equally convinced that they were going to make problems. Sure enough, on about the third day, all of a sudden, particles of feces and food particles suspended in droplets of urine were leaking out of the cages… Taylor [Wang] and I were up on the mid-deck when Bill Thornton opened up the outer cage. Of course, there was supposed to be nothing there to leak between the inner cage and the outer cage, but a large piece of feces came out – obviously, a piece of monkey feces – and it floated all the way up the tunnel very quickly. About ten minutes after it happened, it went floating right by Taylor. I looked at Taylor and I said, 'What was that?' and Taylor said, 'That looked like a monkey turd!' and I said 'Í guess you're right!' and we ended up chasing after it. There was all kinds of junk coming out of the cages. The only way we could solve the problem was to take vacuum cleaners and vacuum up the cages from the outside as best we could, all around the places where they were leaking. Then we took our famous gray tape and taped up all points on the cages where the feed bars are inserted and where the waste management boxes were pulled in and out. I guess I could characterize Bill and my feelings quite strongly by saying that we were pretty perturbed that we had told the management in engineering that we didn't think those cages were going to work very well and they chose to ignore us. They ignored our zero-gravity knowledge, from having been there before – and lo and behold, the cages didn't work very well. I think there's a lesson learned there for somebody." [35]

This mission finally took Don Lind into orbit after a wait of nineteen years. In doing so, he became the seventeenth and final member of the Group 5 astronauts to fly in space, a sequence begun fifteen years before by Haise and Swigert on Apollo 13. Lind's first flight came after some of the Group 6 scientist astronauts and all the Group 7 astronauts had flown. In fact, his only space flight came after several of the eighth and the first of the ninth selections had flown as well.

None of the Group 5 or 7 astronauts were assigned to the next mission (51G), but PJ Weitz and Joe Engle again performed support roles at KSC. Weitz once again shared WX pilot duties with John Young for both launch and for landing, while Engle again served as WX Alternate pilot, flying a T-38. In June, with his STS-51C duties completed, TK Mattingly resigned from NASA and returned to the U.S. Navy as commander of the U.S. Navy Electronic Systems Command, in Washington, D.C.

STS-51F (July 29 – August 6, 1985)

Flight crew: C. Gordon FULLERTON (CDR), Roy D. Bridges (PLT), Karl G. Henize (MS-1), F. Story Musgrave (MS-2), Anthony W. England (MS-3), Loren W. Acton (PS-1), John-David Bartoe (PS-2)
Spacecraft: Challenger (OV-099) 8th mission
Launch Vehicle: Space Shuttle ET/SRB/SSME
Objective: 19th Shuttle mission*;* Spacelab 2 research program; verification of Spacelab Igloo/Pallet configuration
Duration: 7 days 22 hours 45 minutes 26 seconds
Support Assignments: A memo dated July 2, 1985, listed support roles filled by Group 5 astronauts as: KSC WX and landing support pilots: Weitz with Young; Briefer of Headquarters guests: Overmyer.

Spacelab 2 was a dedicated astronomical research flight, with the instruments mounted on unpressurized pallets and an 'Igloo' control unit operated from the orbiter's aft flight deck. This mission recorded a launch pad abort on July 12, delaying the flight until July 29. Following lift-off, the center engine failed, resulting in a much lower orbit than originally planned. Having made it to orbit, the decision was made to use the OMS engines to gradually raise the orbit, allowing the mission fly its full duration. The crew operated two 12-hour shift patterns, with Fullerton working with either shift as required throughout the mission. The Red team was headed by Bridges working with Henize and Acton, while Musgrave led the Blue team, working with England and Bartoe.

STS-51I (August 27 – September 3, 1985)

Flight crew: Joe H. ENGLE (CDR), Richard O. Covey (PLT), James D. A. Van Hoften (MS-1), J. Michael Lounge (MS-2), William F. Fisher (MS-3)
Spacecraft: Discovery (OV-103) 6th mission
Launch Vehicle: Space Shuttle ET/SRB/SSME
Objective: 20th Shuttle mission; satellite deployment and repair mission
Duration: 7 days 2 hours 17 minutes 42 seconds
Support Assignments: A memo dated Aug 8, 1985, lists KSC WX and landing support pilots once again as Weitz with Young

Three satellites were successfully deployed during this mission, including two on the first day. Two EVAs were also conducted to successfully retrieve, repair and then re-launch

Joe Engle during STS-51I. Engle is the only astronaut to have flown two winged vehicles into space – the X-15 three times and the Space Shuttle twice.

by hand the Leasat 3 satellite, which had failed to engage properly after deployment from Discovery *on STS-51D in April.*

On September 19, the same NASA release which named the flight deck crew for the STS-61J (Hubble deployment) mission also included the STS-61K EOM-1 crew, which would be commanded by a veteran Group 5 astronaut.

STS	CDR	PLT	MS1	MS2	MS3
61K	*Brand*	Griggs	Stewart	Garriott	Nicollier (EOM-1)

STS-51J (October 3 – 7, 1985)

Flight crew: Karol J. BOBKO (CDR), Ronald J. Grabe (PLT), David C. Hilmers (MS-1), Robert L. Stewart (MS-2), William A. Pailes, (PS-1, USAF MSE)
Spacecraft: Atlantis (OV-104), 1st mission
Launch Vehicle: Space Shuttle ET/SRB/SSME
Objective: 21st Shuttle mission; maiden launch of Atlantis; 2nd classified DoD Shuttle mission
Duration: 4 days 1 hour 44 minutes 38 seconds
Support Assignments: A memo dated September 19, 1985, again listed KSC WX and landing support pilots as PJ Weitz and John Young.

The military 51J crew led by Bo Bobko (front row, center), with (L to R): Bob Stewart, Dave Hilmers, Bill Pailes (USAF MSE) and Ron Grabe.

This second dedicated DoD mission's crew also included the second – and final – USAF MSE. STS-51J remains one of the most under-reported missions in the 135-flight program. The primary objective of the mission entailed the deployment of a pair of DSCS Comsats into orbit by means of a single IUS. The crew also conducted several medical experiments. But details, as with most of the Shuttle's classified missions, remain sparse. It is worth highlighting that in command of this flight was former MOL astronaut Bo Bobko, the only member of the MOL selection to fly a fully classified DoD mission. Hank Hartsfield had flown on the partially classified STS-4 while Group 5 astronaut TK Mattingly, who commanded both STS-4 and STS-51C, the first fully classified Shuttle flight, had applied for MOL but had been rejected.

STS-61A (October 30 – November 6, 1985)

Flight crew: Henry W. HARTSFIELD, Jr. (CDR), Steven R. Nagel (PLT), Bonnie J. Dunbar (MS-1), James F. Buchli (MS-2), Guion S. Bluford (MS-3), Ernst W. Messerschmid (PS-1, Germany), Reinhard Furrer (PS-2, Germany), Wubbo J. Ockels (PS-3, The Netherlands)

Spacecraft: Challenger (OV-099), 9th mission
Launch Vehicle: Space Shuttle ET/SRB/SSME
Objective: 22nd Shuttle mission; Spacelab D1 (German) research program
Duration: 7 days 0 hours 44 minutes 53 seconds
Support Assignments: A memo, dated October 15, 1985, once more listed the KSC WX and landing support pilots as Weitz and Young, but also noted that Overmyer was assigned to SPAN (alternate) and served as the Briefer for the Headquarters guests.

The final mission by an astronaut from Group 5 or 7 for over four years was commanded by Hank Hartsfield, who headed the largest complete Shuttle crew ever to be flown into and back from orbit on the same vehicle (STS-71, the first Mir docking mission in July 1995, launched with 7 but returned with an additional crewmember). The main objective of STS-61A was to operate the dedicated German Spacelab D1 payload, with the crew of eight split into two 12-hour shifts conducting research in basic and applied microgravity, material and life sciences, technology, communications and navigation. Though the orbiter was controlled from JSC, the scientific operations were controlled from the German Space Operations Center at Oberpfaffenhofen, near Munich – the first time on a manned spaceflight that certain operations were controlled from somewhere other than the United States or the Soviet Union. It was a blueprint for similar operations with the European Columbus laboratory on ISS over 20 years later. Hartsfield was not assigned to a specific shift, working with either team as necessary, as did Ockels. Nagel led the Blue team, working with Dunbar and Furrer, while Buchli led the Red team, working with Bluford and Messerschmid.

None of the Group 5 or 7 astronauts were assigned to fly the next mission, STS-61B, though as usual several provided mission support assignments, as indicated in the memo of November 14, 1985. Weitz and Young fulfilled their usual roles as KSC WX and landing support pilots, while SPAN duties were fulfilled by Brand, Engle, Overmyer, and Fullerton (who acted as an Alternate). Joe Engle also served as Briefer for the guests of NASA Headquarters.

On December 19, 1985, a NASA document updated the announced STS crew assignments though February 1987. Those which featured members of the Class of '66 or '69 were:

STS	CDR	MS
61D [Mission cancelled, with the crew led by *Brand* reassigned to 61K]		
61J		*McCandless*
61K *Brand* (formerly assigned to the now cancelled STS-61D mission)		
62A	*Crippen*	

The support list for the next mission, STS-61C, was released on December 6, 1985 and again listed Weitz and Young as KSC WX and landing support pilots. For this mission, the same quartet fulfilled SPAN duties as for 61B; Brand, Engle, Fullerton, and Overmyer, with Engle also looking after the briefing of Headquarters guests.

Hank Hartsfield (top left) commanded the largest Shuttle crew (STS-61A /Spacelab D1). [Rear, L to R]: Hartsfield (CDR), Bonnie Dunbar (MS), Jim Buchli (MS), Reinhard Furrer (PS, Germany). [Front, L to R]: Ernst Messerschmid (PS, Germany), Wubbo Ockels (PS, The Netherlands), Steve Nagel (PLT), and Guion Bluford (MS).

CHALLENGER

On January 13, 1986, the latest memo listed the support assignments intended for STS-51L. This time, PJ Weitz would have served as landing support WX at Edwards; SPAN assignments fell to Brand (standby), Fullerton, and Overmyer, and Brand was also assigned to brief Headquarters guests. These assignments would not be fulfilled.

On January 28, 1986, Space Shuttle *Challenger* was lost 73 seconds after leaving the launch pad, due to the catastrophic failure of an O-ring seal in the right SRB. The O-ring was not designed to function in the freezing conditions experienced that day at the launch pad and was subsequently found to be the specific cause of the accident. When it failed, a breach occurred in the SRB joint it was meant to seal, allowing pressurized burning gas from within the solid rocket motor to reach the outside, where it acted like an intense blowtorch upon the adjacent SRB aft field strut that attached the booster to the ET.

Group 7 astronaut Don Peterson explained the tragedy: "Some of the things on the Shuttle are not redundant at all. Structure's not redundant. If some major piece of structure fails on the Shuttle, you've just had a really bad day. That's kind of what happened with the *Challenger*. The seal allowed that hot gas to [escape] and it just happened to burn the strut. It separated the strut that holds the solid rocket up against the tank, and the solid rocket turned sideways and punched a hole in the tank. A lot of people think the vehicle was torn apart by the explosion, which is not true. The vehicle was torn apart by the force of the air… when that vehicle turned sideways, the wind force just ripped it apart.

"A couple of things I tell people when I'm talking to them. When we launch the Shuttle and we light all five engines, we're burning ten and a half tons of fuel per second. That's the weight of three full-sized automobiles every second being burned up. The amount of energy and the force and the power that's in that vehicle is gigantic, and it's not as powerful as Apollo [was]. Apollo is more powerful than that. The forces involved are very high, and when you're boring through the atmosphere at high speed, the wind force is tremendous. The Shuttle is not designed to stand big side loads. You've got to keep it pointed exactly properly. Once that rocket came loose and pushed the stack sideways, it just came apart. It just literally disintegrated." [36]

The massive explosion resulted in the deaths of all seven astronauts aboard *Challenger*. As an immediate consequence, all future missions were suspended and crews in training stood down pending an inquiry, following NASA's policy for such events.

On that tragic day, Gordon Fullerton had been out flying. "I was flying a zero-G airplane. That's one thing I did back before ALT and all that, because I had flown at Wright-Pat zero-G. I had kind of started the program at JSC. When we first got a KC-135, I was the initial pilot that checked out the other staff pilots. I had been up flying zero-G; came back. Trying to remember whether they told us to come back early or not. Anyway, when we got back in, I walked back in the ops room, and everybody was down in the mouth, and I learned right away what had happened." [37]

Bob Crippen also recalled that fateful day: "Well, I actually had the 62A crew at Los Alamos in New Mexico, and we were going through one of the experiments that we were going to be flying on the flight. We knew when it [51L] was supposed to lift off, so we managed to get hold of a TV and watched the lift-off, but as was common during that period of time, as soon as it cleared the pad they broke to something else. We tried to find another station, which we didn't, and then we started to go off, and Dale Gardner, who was on the crew, said, 'Well, let's try one more time.' He turned it on, and it had come apart in that time. We could see it, which was devastating for everybody." [38]

Joe Engle, meanwhile, was with Shuttle astronaut Steve Hawley in Kansas: "Steve Hawley and I are both from Kansas, and we had been invited by the governor of Kansas to take part in the annual Kansas Day festivities, which is a formal dinner and a banquet and a ball, and I believe there was a parade involved, too. Steve and I took a T-38 up to Forbes Air Force Base in Topeka [Kansas]. We landed there the morning of the flight, actually. We had buttoned the airplane up and gone into base operations, and we landed about twenty minutes, as I recall, before the scheduled launch time, so by the time we got in, we were able to get all the post-flight activities done. They had a television set up in the base operations waiting room or lounge area there. I think it's there all the time anyway, but they asked us if we would like to watch the launch and, of course, we were kind of hoping that there would be a place where we could watch it. So, we went in there along with the people who were manning the base operations at the Air Force Base there and the folks from the governor's office who had come out to meet us and take us in town. Steve and I watched the last few minutes of countdown and watched the launch until the breakup; so, we were there at base operations at Topeka. I remember Steve being a little bit concerned about

The announced but unflown STS-62A crew. [Rear, left to right]: Air Force Undersecretary Edward 'Pete' Aldridge (PS), Crippen (CDR), Brett Watterson (USAF MSE). [Front, left to right]: Guy Gardner (PLT), Mike Mullane (MS), Jerry Ross (MS) and Dale Gardner (MS).

what we should do, and I remember telling him… in fact, I don't remember saying a whole lot of words. I think I told him, 'You go file a flight plan back to Ellington and I'll call the governor's office and explain that we're not going to be there.' So, by the time I had finished the call, he had the flight plan ready and we turned right around and came back." [39]

When asked what his duties were after returning to Houston, Engle responded: "Of course, we didn't know what was going to be done. I think things were still not organized completely into focused groups. There was an Accident Investigation Board in the process of being formed. We were not part of that. As a matter of fact, I think Bob Crippen was one of the few from the Astronaut Office who was on that board. But I do recall immediately taking part in the almost continuous Shuttle mission simulator runs, which were attempting to duplicate all the conditions of the launch. At that time, the cause of the accident had not been determined. Nobody had any idea what it was. They suspected high-altitude wind shears and, of course, they had gone back and gotten the wind profiles and fed that into the simulator. We were flying launch profiles, trying to determine if there were areas where structural stress or overload had happened during the boost." [39]

On the day *Challenger* was lost, Karol Bobko was in Morocco helping to set up a new Transoceanic Abort Landing (TAL) site. He was critical in his assessment of the compressed schedule that had led to the accident. "Well, NASA had been, I think, rather cavalier in expecting the Shuttle to be something that you could just throw passengers on, and when the accident occurred, it caused them to go back and look at everything in the program, look at every nook and cranny, and in the time that was required to get the rockets back up, they spent that time really polishing all of their procedures and making sure things were done right." [40]

Truly returns to NASA

On February 20, 1986, former MOL and NASA astronaut Rear Adm. Richard H. Truly became the new NASA Associate Administrator for Spaceflight. He was to head the Shuttle program and direct the agency's Design and Data Analysis Task Force, reviewing the *Challenger* accident [41]. It was a position he held until May 1989, when he succeeded James Fletcher as the new Administrator of NASA (see page 383), becoming the first former astronaut to lead the agency.

RETURN TO FLIGHT

In the months following the *Challenger* accident, the focus remained on the inquiry and establishing the cause of the tragedy. As work at NASA concentrated upon returning the Shuttle to flight, it became clear that it would be many months before any American astronaut left the launch pad again. Some of the older astronauts who were not assigned to flights prior to the accident took the opportunity – however untimely it might seem – to leave the agency and seek new careers, leaving the flight manifest open to more recently selected astronauts.

When he returned from the STS-51B mission in April 1985, Don Lind had already decided it would be his one and only space flight. "It takes several months to go through [all the] debriefing, and I thought, 'I am to the point in my life where if I'm ever going to shift into academia, I better do it now, or I will end up as a NASA manager for the rest of my life.' So as soon as we essentially finished the debriefing, I put in a resignation. As I recall, I signed it on the 12th of November '85 to go into effect the 1st of July '86, so I could start teaching the fall of '86. I was going to spend [the intervening] time choosing the university to go to. Well, right after that we had the problems [of the *Challenger* accident]. A number of [astronauts] said to me, 'Oh, man, I wish I had done what you did, but if I resign now, it's going to look like cowardice.' So I was the first one to leave the program after the big accident, but I had already done the paperwork much [earlier]." [42]

In March 1986, Lind formally announced he would be leaving NASA in July to become a professor of Physics at Utah State University from the start of the new semester that fall. On June 1, Bob Overmyer retired from the USMC and NASA to form his own aerospace consulting firm, Mach25 International, based in Houston. Then, in October, Gordon Fullerton was reassigned from the Astronaut Office to become an aerospace test pilot at NASA's Dryden Flight Research Facility in California. The following month, on November 30, Joe Engle also left both the USAF and NASA, to become an aerospace consultant to the Kansas Air National Guard and for Rockwell International on the National Airspace Plane project.

Meanwhile, Bob Crippen had been assigned a new role in support of the post-*Challenger* investigations. On June 11, NASA Administrator James Fletcher and Associate Administrator Richard Truly announced that the veteran Shuttle astronaut would head a small group to examine the overall Space Shuttle management structure. Crippen's team would review the findings and conclusions of the Rogers Commission into the *Challenger* accident and the suggestions made by fellow astronauts that they should participate more closely in management decisions. There was a strong desire within the Office to create a Shuttle safety panel and improve the lines of communications within the Shuttle program. Prior to this appointment, Crippen had served as Vice Chairman of the 51L Design and Data Analysis Task Force, which was about to be disbanded as their work neared completion. His new team closely reviewed the lines of authority in the management of the Shuttle program and set about resolving communications problems as outlined in the Rogers Commission report. [43]

A NEW DIRECTION

The loss of *Challenger* forced the entire Shuttle fleet to be grounded, pending the outcome of the inquiry and introduction of the necessary recommendations for a Return-to-Flight program. All assigned crews were stood down and continued only generic training, awaiting formal reassignment once the Shuttle was cleared to fly again. The manifest for 1986 and beyond was scrapped and all missions were put on hold. On February 10, NASA announced that the Shuttle launches of Ulysses to study the Sun's poles, the Galileo mission to orbit Jupiter and deploy a probe into the planet's atmosphere, and the Astro-1 laboratory to observe Halley's Comet had been postponed, due to the accident and the passing of primary launch windows for their deployment. [44] The following day, the *Washington Post* newspaper reported that NASA advisors had concluded that total reliance on the Shuttle for all space operations was in fact contradictory to the idea of a reliable 'Space Transportation System.' Their conclusion was that more effort should be directed towards expendable launch vehicles because "the Shuttle was a research vehicle," despite the claim that it had been 'operational' since November 1982. [45] NASA's own safety board stated in their annual report for 1985 that 18 Shuttle flights each year was "very optimistic," and that as a result of the *Challenger* accident, NASA was forced to reconsider using expendable launch vehicles as an alternative means of placing satellites into orbit.

By early March 1986, NASA was evaluating the consequences of the *Challenger* accident on the Shuttle program and the future manifest. A series of decisions needed to be addressed: [1] whether to still fly the Centaur Upper Stage; [2] authorizing a new orbiter; [3] the implications from the loss of an IUS and TDRSS satellite; [4] revised launch schedules for three orbiters; [5] the use of the Vandenberg launch site. With the fleet not expected to return to operational status for 12 to 18 months (it was actually 32 months), customers who had booked on the Shuttle were forced to evaluate alternative launch systems. Clearly, national military and scientific payloads were of a higher priority than commercial ones, but the Pentagon warned that a one-year delay could create a backlog of 10 military missions, or 21 missions if it stretched to two years.

On June 19, NASA announced the termination of the Centaur Upper Stage. Expected delays to the resumption of flights meant the USAF had already begun moving their payloads across to expendable launch vehicles, although they supported the plan to build a new fifth orbiter. With the loss of *Challenger*, however, and continued delays to the program, the USAF lost interest in the Shuttle and decided to abandon plans to launch an orbiter from Vandenberg AFB, costing NASA both the opportunity to launch payloads into polar orbit and more flight seats. With the remaining DoD payloads locked into the schedule for some time, there was no need to retain a DoD launch ready standby crew and the idea was dropped during the downtime before STS-26.

For the Astronaut Office, the difficult year which had seen the loss of a crew, the grounding of the Shuttle fleet and the departure of several veteran astronauts indicated the changing face of the Shuttle program. By the end of the year, many of the members of Group 5 and 7 had departed NASA, moved onto managerial roles, or were in line to assume such responsibilities and therefore step aside from flight status, leaving the resumption of flights to the new generation of Shuttle astronauts. The year ended with the news that another member of the Class of '66 had moved into a managerial role with the space agency. On December 31, 1986, PJ Weitz was named Deputy Director of JSC. [46]

Generic Training

By the start of 1987, several 'crews' were in limbo, completing some form of basic and generic training to maintain proficiency, and assigned to other duties as the return to flight imperative continued. They included Bruce McCandless, assigned to the Hubble deployment crew, and Vance Brand on the EOM crew. Bob Crippen had been reassigned from the 62A crew and was eventually replaced, in September 1988, by Group 8 pilot Robert 'Hoot' Gibson, on what would now be the STS-27 mission.

In April 1987, NASA announced further managerial assignments for several veteran astronauts [47]. Hank Hartsfield became Deputy Director of Flight Crew Operations replacing Crippen, who became the new Deputy Director for Shuttle Operations at KSC, Florida (see page 369), based on his suggestions to Dick Truly, who then asked Crippen to take on the role. Other managerial appointments included Karol Bobko as Assistant Operations Director, FCOD.

RECOVERY

On March 17, 1988, Bruce McCandless was named with the former 61J crew to the newly designated STS-31, still manifested to deploy the HST, but now commanded by Loren Shriver, who had replaced John Young after his reassignment to a managerial role. [48] With the resumption of Shuttle flights, beginning with STS-26 in September 1988, the remaining Group 5 and 7 astronauts continued to support missions while awaiting new flight assignments themselves. The STS-26 support memo listed Vance Brand as Mishap Representative at JSC. Then, on November 30, Brand was named CDR for STS-35/Astro 1. After flying STS-41B in February 1984, Brand had retained a desire to get back into space and informed management that he would like to command one more space mission. Unfortunately, his assignments to Spacelab 4 and EOM-1 did not work out the way he wanted, but with STS-35 he at last got his final chance to return to orbit. [49]

STS	CDR	PLT	MS1	MS2	MS3
35	*Brand*	Gardner G.	Hoffman	Lounge	Parker plus PS

Brand had replaced Jon McBride, who had resigned from NASA in April 1988 and was no longer assigned to the Spacelab Life Science or EOM missions. The following month, during STS-27, Brand repeated his role as Mishap Representative at JSC.

On January 1, 1989, Bo Bobko resigned from NASA and from the USAF to accept a position with the Houston-based space division of Booz, Allen and Hamilton, where he would direct that company's consultancy work on the *Freedom* Space Station. He had spent three years as a MOL astronaut and almost 20 years at NASA. For some time, he had been tipped to fly a fourth mission, including being a strong candidate to command the second crew out of the Vandenberg launch site, but with the cancellation of Shuttle launches from that base and a long line of newer astronauts waiting for their first flights, it was time to move on.

With both *Discovery* and *Atlantis* now returned to operational flights, the timetable to catch up delayed payloads saw the manifest increase significantly during the year. In the support assignment lists released during the year, familiar names appeared for each mission. For STS-29, Vance Brand was listed as Mishap Representative at JSC, a role he continued to serve in for STS-30, -28 (the return to flight of *Columbia*), and -34. Hank Hartsfield was a member of the JSC FCOD management support team for the launch, orbit and landing phases of STS-30. Though no longer assigned to the Office, Gordon Fullerton was listed as one of the SCA pilots to ferry the orbiter back to KSC for STS-30, -28, -34 and -33. Interestingly Al Crews, the former MOL astronaut who missed out on a transfer to NASA in 1969, was still working as a pilot for NASA and was listed as a member of the Crew Recovery Team from TAL sites, flying the KC-135 for STS-28 and STS-34. Finally, Brand was assigned as a TAL support for STS-33, the final mission of the year. By the end of 1989, only McCandless and Brand of the 1966 or 1969 selections retained active astronaut status.

Swansong

The year 1990 proved to be the last in which members of the final two classes of original pilot astronauts would fly in space.

The first mission of the year, STS-32 in January, finally retrieved the LDEF experiment payload deployed from Bob Crippen's STS-41C mission nearly six years earlier. In the support assignments release, Vance Brand once again served as Mishap Representative at JSC and Bruce McCandless worked in SPAN. Gordon Fullerton was again one of the SCA ferry pilots returning *Columbia* from its landing at Edwards to KSC.

Times were changing for the global space program in the new decade. The prospective large space station program, *Freedom*, was not only in serious trouble, it was on the verge of cancellation. Over in the Soviet Union, there was growing turmoil in the running of the country and in support of their space program. Outwardly, there were visible signs of friendlier relations and an indication of future cooperative partnerships. Though the details were vague and much needed to be done, no one could have foreseen the dramatic events of the early 1990s in that country.

Ties between American and Soviet cosmonauts had remained strong since Apollo-Soyuz (ASTP) fifteen years before, and in late 1989, a small group of astronauts was invited to visit the Soviet Union by the cosmonauts' chapter of the Association of Space

Explorers (ASE). This tour occurred between February 9 and 14 and included Group 5 astronaut (now Deputy Director of JSC) PJ Weitz, Group 8 astronaut and Chief of the Astronaut Office, Dan Brandenstein, recently back from commanding STS-32, and Group 9 astronauts Ron Grabe and Jerry Ross. [50] The invitation included a trip to Baikonur Cosmodrome to view the Buran Shuttle and witness a Soyuz launch (Soyuz TM-9 to Mir on February 11), as well as a tour of the Soviet Mission Control and the cosmonaut training center at Star City. In 1991, the Soviet Union collapsed, and just two years later, the new Russia became the latest partner in the former *Freedom* Space Station program, now renamed the International Space Station (ISS). Visits such as the one conducted in February 1990, arranged through meetings of the ASE, helped continue the ties forged during ASTP and move towards the next major goal in space – the cooperative venture to build and operate a large international station in space.

Meanwhile, Shuttle missions continued, rebuilding confidence in the program after the return to flight, as well as clearing the backlog of payloads left grounded in the wake of losing *Challenger*. On February 28, the classified STS-36 was launched. Once again, the support assignment listing showed Vance Brand as Mishap Representative at JSC and he also served on the second shift assigned to the Shuttle Mission Simulator. With *Atlantis* landing at Edwards, the team of SCA pilots, including Gordon Fullerton, were required to bring the orbiter back to Kennedy for its next mission.

McCandless during contingency EVA preparations aboard STS-31, the Hubble Space Telescope deployment mission.

STS-31 *(*April 24-29, 1990)

Flight crew: Loren J. Shriver (CDR), Charles F. Bolden, Jr., (PLT), Bruce McCANDLESS II (MS-1), Steven A. Hawley (MS-2), Kathryn D. Sullivan (MS-3)
Spacecraft: Discovery (OV-103), 10th mission
Launch Vehicle: Space Shuttle ET/SRB/SSME
Objective: 35th Shuttle mission; deployment of Hubble Space Telescope (HST)
Duration: 5 days 1 hour 16 minutes 6 seconds
Support Assignments: Mishap Rep JSC: Brand; SMS Support 1st Shift: Brand; SCA pilot: Fullerton

After nearly three decades of development, the large space telescope named Hubble was finally deployed during this mission. The deployment phase was not without its challenging moments, almost requiring a contingency EVA by McCandless and Sullivan to assist in the deployment. In the end, the spacewalk was not needed and the telescope was deployed as planned. This was the highest altitude a Group 5 or 7 astronaut attained on the Shuttle (372.8 miles, or 600 km), making McCandless the highest flier of those from his group who did not venture out to the Moon.

On August 31, 1990, four months after flying STS-31, Bruce McCandless resigned from NASA and retired from the USN to enter private industry. He joined Martin Marietta Astronautics Group in Denver, Colorado, working as a consultant on the first Hubble Servicing Mission planned for 1993. The following month, Hank Hartsfield was reassigned as Deputy Director of Operations in the *Freedom* Space Station Office at MSFC in Huntsville, Alabama. In the months prior to his final flight, Brand completed his final support role for STS-38, working on the first shift of the SMS. Once again, Gordon Fullerton was a member of the SCA team of pilots who returned the orbiters *Discovery* (STS-41) and *Atlantis* (STS-38) back from Edwards to KSC, a role he would continue for some years.

STS-35 (December 2-10, 1990)

Flight crew: Vance D. BRAND (CDR), Guy S. Gardner Jr., (PLT), Jeffrey A. Hoffman (MS-1), J. Michael Lounge (MS-2), Robert A.R. Parker (MS-3), Samuel T. Durrance (PS-1), Ronald A. Parise (PS-2)
Spacecraft: Columbia (OV-102) 10th mission
Launch Vehicle: Space Shuttle ET/SRB/SSME
Objective: 38th Shuttle mission; Astro-1 astronomical research program
Duration: 8 days 23 hours 5 minutes 8 seconds

The final flight of 1990, closing the first decade of Shuttle flight operations (although STS-37 landed on April 11, 1991, the day before the 10th anniversary of STS-1). This mission flew three ASTRO-1 experiment suites on pallets in the payload bay, conducting surveys in UV and X-ray astronomy. It was also the final mission to include a member of the 1966 or 1969 selections, ending an era begun on Apollo 13 twenty years previously.

"After my last spaceflight, my thoughts turned to leaving the Astronaut Office and JSC to pursue other NASA employment opportunities," Brand wrote in 2015. At the age of 59, he believed he was at the "top of his game as an astronaut," but he also knew that nothing he would do next could ever beat flying in space. It was time to retire from the active flight list. His desire was to move into project or program management. "I had several weeks of debriefing and months of public relations after the flight," he recalled in 2016. "By the beginning of 1992, I was travelling to Dayton before we finally moved the family in early spring of 1992." [51] Brand finally left the Office after 26 years to become Chief of Plans,

'Wheel stop' at the end of an era. Don Puddy (center), the JSC Director of Flight Crew Operations, joins the STS-35 crewmembers in a post-landing walk-around inspection of *Columbia* at Edwards. Crewmembers include (L to R): Vance Brand, Mike Lounge, Ron Parise, Guy Gardner and Jeff Hoffman. Brand had just completed the final spaceflight by a member of the Class of '66 or '69.

National Aerospace Plane (NASP) Joint Program Office, Wright-Patterson AFB, Dayton, Ohio, remaining there until 1994.

WHEELS STOP

When Vance Brand brought *Columbia* to a wheel stop on Runway 22, at Edwards AFB, California, not only had he completed his fourth mission but, at 59, he had become the oldest and the last member of the Class of '66 or '69 to fly in space. He was also the last member of the original 73 astronauts chosen in the first seven NASA groups to make a space flight, a log book begun by Al Shepard on May 5, 1961, and officially closed by Brand on 10 December 1990. In October 1998, as a footnote to this history, 77-year-old former Mercury astronaut and U.S. Senator, John Glenn, flew for a week as a 'politician' PS on STS-95. While one of the first seven of the 'original 73' had returned to orbit, Glenn had not been a career astronaut for over 34 years, and retired shortly afterwards.

It had been a remarkable record for both the Class of 1966 and that of 1969, as both groups were faced with the prospect of a long wait to make their first missions. As groups, they had remained at the space agency from the transition of Gemini into Apollo and that of Apollo into Shuttle, and almost into the era of ISS.

References

1. JSC News, JSC-76-44, July 6, 1976
2. *Weitz Retires, Goes Civilian*, JSC Roundup May 21 1976 Vol. 15, No. 10 p. 4
3. *Simulating Spacelab, **NASA's Scientist-Astronauts***, David J. Shayler and Colin Burgess, Springer-Praxis 2007, pp. 288-327
4. *Inside Spacelab photo caption*, JSC Roundup, November 19, 1976 Vol. 15, No. 23, p. 4
5. ***Astronauts and Aeronautics 1976 a chronology***, Eleanor H. Ritchie, NASA SP-4021, 1984, pp. 222-223
6. Email to David J. Shayler from Michael Cassutt, December 23, 2016
7. ***But for the Grace of God***, William R. Pogue, Soar with Eagles publishers, 2011, pp. 289-294
8. *Egress Exercise in Building 9*, JSC Roundup, Vol. 17, No. 18, September 15, 1978, p. 4
9. *Crew Training Countdown; Prelaunch Sims Underway in FOD;* and *Life and Work on Orbiter Takes Practice*, JSC Roundup, Vol. 18, No. 2, January 26, 1979, p. 1
10. *Taking Hubble Underwater,* ***The Hubble Space Telescope, From Concept to Success***, David J. Shayler with David M. Harland, Springer-Praxis, 2016, pp. 213-239
11. NASA News Release, 79-34, May 23, 1979
12. *T-38s Simulate Landing*, JSC Roundup, Vol. 19, No. 13, June 27, 1980, p. 1
13. NASA News Release 81-015, April 23, 1981
14. NASA News Release 81-047, November 30, 1981
15. Email to author David J. Shayler from Vance Brand, December 23, 2016
16. JSC News, JSC-82-012, March 2, 1982
17. NASA News Release 82-71

18. ***Who's Who in Space, International Space Station Edition***, Michael Cassutt, 1999, p. 257
19. *Robert Crippen: Two Years After STS-1, 'Crip' gets Ready to Go Up Again*, JSC Roundup Vol. 21, No. 19, October 1, 1982, pp. 3-4
20. JSC News, JSC-82-046, October 20, 1982
21. *Truly to Assume US Navy Post*, JSC Roundup, Vol. 22. No. 16, September 16, 1983, p. 1
22. JSC News, JSC-83-036, September 21, 1983
23. JSC News, JSC-83-039, September 28, 1983
24. JSC News, JSC-83-046, November 17, 1983
25. ***The Long Duration Exposure Facility (LDEF) Mission 1 Experiments***, NASA SP-473, 1984, pp. 98-100
26. JSC News, JSC-84-029, June 8, 1984
27. JSC News, JSC-84-036, August 3, 1984
28. NASA News 84-97, July 16, 1984
29. Email to David J. Shayler from Steve Hawley, December 2016
30. NASA News 84-050, October 17, 1984; *Crippen named Deputy for Crew Operations*, JSC Roundup, Vol. 23, No. 19, October 19, 1984, p. 1
31. JSC News, JSC-84-052, November 15, 1984
32. *Two Crews announced*, JSC Roundup, Vol. 24, No. 2, February 1, 1985, p. 1
33. JSC News, JSC-85-25, February 15, 1985
34. NASA News, Headquarters, HQ-85-34, March 6, 1985
35. Bob Overmyer quoted from *Overmyer's Ark* article, *Space Flight News* magazine, issue 13, January 1987, pp. 34-47
36. Donald H. Peterson: interview by Jennifer Ross-Nazzal for NASA's Oral History Project, Houston, Texas, November 14, 2002
37. C. Gordon Fullerton: interview by Rebecca Wright for NASA's Oral History Project, NASA Dryden Flight Research Center, California, May 6, 2002
38. Robert L. Crippen: interview by Rebecca Wright for NASA's Oral History Project, Houston, Texas, May 26, 2006
39. Joe H. Engle: interview by Rebecca Wright for NASA's Oral History Project, Houston, Texas, June 24, 2004
40. Karol J. Bobko: interview by Summer Chick Bergen for NASA's Oral History Project, Houston, Texas, February 12, 2002
41. NASA News Release 86-15, February 20, 1986
42. Don L. Lind: interview by Rebecca Wright for NASA's Oral History Project, Houston, Texas, May 27, 2005
43. *Crippen to Head Management Study Group,* JSC Roundup, Vol. 25, No. 11, June 27, 1986, p. 1
44. NASA News Release 86-11, February 10, 1986
45. *Washington Post*, February 11, 1986
46. NASA News Release 86-183 December 31, 1986
47. NASA News Release 87-021 April 27, 1987
48. JSC News, JSC-88-008, March 17, 1988
49. ***Flying Higher and Faster***, Vance Brand, Mira Digital Publishing, 2015, p. 156
50. NASA News Release 90-013, February 1, 1990
51. Email to David J. Shayler from Vance Brand, December 23, 2016

11

After space

"I thoroughly enjoyed my 25 years at Johnson Space Center and the great experience of working on the programs from Apollo through Space Shuttle."
Vance Brand, upon his departure from the Astronaut Office, NASA News Release, March 12, 1992.

One by one, the members of the 1966 and 1969 selections retired from the active flight list. While some moved into management roles, a few returned to their parent service, moved into the aerospace industry, or assumed consulting roles. Each of them has since had a varied and interesting life outside of the military and NASA, as briefly summarized here.

HANGING UP THE SPACESUIT

Karol 'Bo' Bobko

At one point, Bobko was a strong contender to command the second Shuttle mission out of Vandenberg Air Force Base (AFB) in California, before it was mothballed. He retired from NASA on November 30, 1988 and from the U.S. Air Force on January 1, 1989. He then joined the Space Systems Division of Booz, Allen & Hamilton and was involved in space station *Freedom* program support activities. In 2000, he became vice president for Strategic Programs for Spacehab, Inc., in Houston, Texas, and four years later joined Science Applications International Corporation (SAIC) as program manager for the NASA Ames Research Center Simulation Laboratories contract.

Among his many decorations, awards and honors, Bobko received the Defense Superior Service Medal; the Legion of Merit; Distinguished Flying Cross; Defense Meritorious Service Medal and Meritorious Service Medals (1970 and 1979) and two NASA Exceptional Service Medals. He was inducted into the U.S. Astronaut Hall of Fame on May 7, 2011. [1]

D.J. Shayler, C. Burgess, *The Last of NASA's Original Pilot Astronauts*, Springer Praxis Books, DOI 10.1007/978-3-319-51014-9_11

Karol Bobko, the first Commander of OV-104 *Atlantis*, during decommissioning ceremonies at Cape Canaveral, Florida, on November 2, 2012. [Inset] Vance Brand, Assistant Chief of Flight Operations, NASA Dryden.

Vance Brand

In March 1992, after 26 years as an active astronaut, Vance Brand became the last member of the 1966 or 1969 astronaut intakes to depart the Astronaut Office. He went to work on the National Aerospace Plane (NASP) project at Wright-Patterson AFB, Ohio. When that project was cancelled, he transferred to NASA's Dryden Research Center at Edwards AFB, in California, as assistant chief of Flight Operations. He subsequently served as deputy director for Aerospace Projects, then acting associate center director for Programs. In January 2008, after 42 years' service, Brand finally retired from NASA aged 76. Fifty years after applying for the fifth group of astronauts, and after many years of being asked by family and friends to write about his experiences as a pilot and astronaut, Brand published his autobiography, *Flying Higher and Faster,* in 2015.

John Bull

After leaving the Astronaut Office in July 1968, Bull remained with NASA. "We found him a job at the NASA Ames Research Center in Palo Alto, California, where he did some research flying and went on to get a PhD," former Mercury astronaut and Director of Flight Crew Operations 'Deke' Slayton later wrote of Bull in his memoirs. "He was a great guy and would have been one of my early picks for a Lunar Module Pilot. I hated to lose him." [2]

In 1971, Bull took leave from his work at Ames to complete a master's degree in Aeronautical Engineering at Stanford University, subsequently undertaking his PhD, also in Aeronautical Engineering, which he achieved in 1973. He then returned to the NASA Ames Research Center, where, over the next twelve years, he conducted simulation and flight test research of advanced flight systems for both helicopters and fixed-wing aircraft. One of Dr. Bull's first assignments was to investigate the feasibility of landing the Space Shuttle without engines.

Sadly, John and Nancy's first son Jeffrey passed away in 1977. He was just 11 years old. Unknown to anyone, he was suffering from a heart abnormality that resulted in a sudden, fatal cardiac arrest. His younger brother Scott remembers a devastated father who tried to be "very strong" during the difficult time. "I never recall seeing sadness in him, but I know how painful this must have been," he reflected. John Bull may have been an astronaut, but he was also a father. "We always had paper airplanes all around the house that he would design for us. Model planes became a connection that I carried with my dad through college. We did a lot of family water-ski trips before Jeff died. As well, Dad took me and my brother to Oakland A's baseball games and some high school football games. He once walked out of a meeting at the Johnson Space Center because he did not want to miss my high school football game. He also coached many of our sporting teams and would keep lots of team statistics, which I understand now because he had such a mathematical mind." [3]

Around 1983-84, Bull became chief of Ames' Aircraft Systems Branch, where he managed the development of research flight control systems for rotorcraft and Short Take-off and Landing (STOL) aircraft. Then, from 1986 until his retirement in 1989, he managed NASA-wide research programs in autonomous systems technology for aeronautics and space applications.

Following his retirement from NASA, Dr. Bull stayed close to the Ames family, providing technical support and consulting services for aerospace research and technology programs. Now working for the CAELUM Research Corporation, he and his team made several important contributions in advanced flight control law design for the Propulsion Controlled Aircraft (PCA) program, with applications to the MD-11 and Boeing 747 commercial aircraft. Prompted by several airplane crashes caused by the loss of hydraulic flight controls, a NASA-industry team at Dryden was working with Ames to develop an effective method of safely landing an airplane, using a computerized PCA system which required only engine thrust to give the aircraft emergency flight control. The team, led by Bull, successfully developed such a system, demonstrating PCA on simulations for generic commercial airliner models.

Joseph J. (Joe) Totah, the current associate chief of the Intelligent Systems Division at NASA Ames, offered his personal reflections by stating, "It was truly a privilege working with John Bull. His technical expertise and wealth of experience were remarkable, and we all learned so much from him. John was eager to share the many successes he achieved in his research – he taught us how to analyze complex problems with simple, yet elegant solution techniques. He led by example, and was a source of knowledge, insight, and inspiration that provided the foundation for our successes in both aeronautics and space technology projects and studies." [4]

Prior to his final retirement in 1997, Bull's contributions extended to several other projects and studies, including advanced flight control for lunar-lander and autonomous docking applications. He also conducted research and development in high-visibility NASA systems directed toward space missions and science operations, including the Access to Space Initiative, the International Space Station (ISS), the Space Shuttle program, Mars Pathfinder and Deep Space One.

Al Worden had been selected by NASA in the same Group 5 as John Bull, and he would later journey to the Moon as Command Module Pilot (CMP) on Apollo 15. Post-flight, he would also take on a position at the Ames Research Center. "[Bull] was a great guy," Worden told author Colin Burgess. "John was very much like another well-liked astronaut named C.C. Williams – quiet and modest, a very competent guy who came out of the Navy. But when he had his health problem, which is why he left the program, there was no place for him back in the Navy. So he went out as a researcher to Ames. I also went to work at Ames following my Apollo 15 flight, and he was in their Aircraft Systems Branch. There was kind of a sense of 'Hey, here we both are.' But I only saw him every once in a while. We'd say 'Hi' and all that, but we weren't really close. The fact that we were in the same group in Houston was kind of tenuous, as John wasn't there that long. So we never really got back together in any meaningful way at Ames or developed a deeper connection." [5]

In 1979, Dave Anderson, now a pilot for a major American airline, began working at NASA Ames after being interviewed at the University of California at Davis by John Bull. "Whatever happened in that interview resulted in my starting my career in aviation at NASA working for John. When I arrived at Ames, I was given a tour of the facility by a fellow engineer who had started about a year before I did. He mentioned that John had been an Apollo astronaut, selected in the 5th group. John never said anything during the interview.

"John was a very soft spoken man and very intelligent. My life goal was to be a pilot and I think that was possibly the reason that I was hired. There was a connection between us and he literally took me under his wing and did whatever he could to help guide me in that direction. That included giving me his test pilot manuals from Navy Test Pilot School. In the three-and-a-half years I worked for John, he never talked about his time as an astronaut. He was very professional and you would never, for a second, guess that there was any angst about being let go from the Apollo program due to health reasons. He never talked about it. He did talk about flying, though, and he would light up when talking to me about my dreams. One story that was told to me by the secretary on the second floor of building 210 [she covered all the engineers on the floor] was on the 25th anniversary of the Apollo 11 Moon landing, when she started to get letters written to John asking for an autograph. She asked John why he was getting these letters. It was only then – after 25 years – that he told her he had been an Apollo astronaut. She had never known. That was the kind of man he was." [6]

At the time of his retirement in 1997, Bull was a Member of the Society of Experimental Test Pilots (SETP), the American Helicopter Society, and the American Institute of Aeronautics and Astronautics (AIAA), as well as a member of Sigma Tau, Sigma Xi and Tau Beta Pi (the oldest engineering honor society in America). [7] Having raised their family in the San Francisco Bay area, the Bulls retired to South Lake Tahoe in 1998. In the years prior to his death, Lt. Cmdr. (Dr.) Bull resumed recreational flying in his Piper Comanche 250, making short trips with friends and family to and from the local airport. [8]

John Bull died in South Lake Tahoe, California, on August 11, 2008, aged 73, following complications related to long-term asthma. He was laid to rest at the Alta Mesa Memorial Park in Palo Alto, California. He is survived by his wife Nancy, a son, his daughter and four grandchildren. In eulogizing her late husband, Nancy Bull said, "We will remember John as a loving husband, father and grandfather who lived life to the fullest and always found the positive side of things no matter what the situation." [8]

Jerry Carr

Following his retirement from NASA on June 27, 1977, Jerry Carr joined Bovey Engineers in Houston, Texas. He and JoAnn were divorced in 1978 and the following year, on September 14, 1979, he married for a second time to professional artist Patricia Musick. In February 1981, Jerry joined Applied Research Inc., and between 1983 and 1985 he worked as a project manager for the University of Texas McDonald Observatory. In 1985, Jerry and Pat formed the family company CAMUS, a contraction of their surnames, working in both airspace consultancy and artistic commissions with former astronaut colleagues, who were subcontracted by CAMUS for several space consultancy projects. Jerry's consultancy work included significant activities on Space Station *Freedom* definition studies for Boeing, such as underwater EVA simulations in a Shuttle EVA pressure garment for the company. There was also work carried out with the Italian firm Alenia Spazio, on human factors and operational support in the design of the *Freedom*/ISS European science module *Columbus*; with Vought Aerospace on the evolution of the proposed Orbital Maneuvering Vehicle control station; and Space Station integration support studies for TRW and with the Essex Corporation on a number of conceptual studies for Advanced EVA Systems for geosynchronous orbit, lunar base operations and the human exploration of Mars.

Jerry Carr (CAMUS) wearing a Shuttle EMU suit during underwater EVA simulations, in support of Space Station *Freedom*/ISS development while under contract to Boeing.

After twelve years, Jerry retired from CAMUS aerospace operations and ceased flying as a private pilot in 1997, to work full time supporting his wife's art commissions and publications. He is now involved as an associate designer and fabricator of wall-hung and free standing sculpture with his wife. Carr was inducted into the U.S. Astronaut Hall of Fame on October 4, 1997. Today, Jerry and Pat Carr live in Vermont. He has six children (including two sets of twins) with his first wife JoAnn, and three step-daughters from Pat's first marriage, and enjoys an extended family of several grandchildren and great-grandchildren.

At the time of his retirement from NASA in 1977, Col. Carr had logged 8,300 hours of flying time and achieved numerous awards and medals, including the Marine Corps Aviation Association's Exceptional Achievement Award and the NASA Distinguished Service Medal in 1974. After many years of encouragement to write his story, and having decided that self-penning his biography held less attraction than a visit to the dentist, his authorized biography *Around the World in 84 Days,* written in cooperation with author David J. Shayler, was published in 2008.

Bob Crippen

From July 1987 to December 1989, Bob Crippen was assigned to the Kennedy Space Center (KSC) as NASA's Deputy Director, Shuttle Operations, responsible for final Shuttle preparation, mission execution and return of the orbiter to KSC after landings at Edwards AFB in California. From January 1990 to January 1992, he served as director for Space Shuttle at NASA Headquarters in Washington, D.C. As such, he was responsible for the overall Shuttle program requirements, performance, and total program control, including budget, schedule and program content. While there, he retired from the U.S. Navy in 1991 with the rank of captain. He subsequently became the first former astronaut to become a director of a NASA field office, serving as the fifth director of KSC from January 1992 to January 1995, after which he resigned from the space agency. During his tenure, the center processed, safely launched, and recovered 22 Space Shuttle missions. [9]

Crippen next served as vice president of Training Simulation Systems at Lockheed Martin Information Systems. In December 1996, he became president of the Thiokol Propulsion Group, Brigham City, Utah. This newly-established group comprised three divisions; Space Operations, Defense and Launch Vehicles, and Science and Engineering. Crippen retired as president of Thiokol Propulsion in April 2001. [10]

On April 6, 2006, Capt. Robert Crippen received the Congressional Space Medal of Honor, the highest award for spaceflight achievement, for his role as the first pilot of a Space Shuttle mission. He has won many other awards, including the NASA Outstanding Leadership Medal (1988); Distinguished Service Medals (1985, 1988, 1993); U.S. Navy Distinguished Flying Cross (1984); Goddard Memorial Trophy (1982), Harmon Trophy (1982); NASA Space Flight Medals (1981, 1983, and two in 1984); NASA Distinguished Service Medal (1981); Department of Defense Distinguished Service Award (1981); American Astronautical Society (AAS) Flight Achievement Award (1981); the SETP Iven C. Kincheloe Award (1981); and the NASA Exceptional Service Medal. [9] Crippen was inducted into the U.S. Astronaut Hall of Fame on November 10, 2001. At the National Business Aviation Association convention in Las Vegas, on November 18, 2015, he was announced as a 2016 inductee into the National Aviation Hall of Fame. [11]

Crippen's first marriage to the former Virginia Hill, which ended in divorce, produced three daughters. His second marriage, on 7 November 1987, was to Pandora Lee Puckett of Miami, Florida, NASA's first female lead orbiter project engineer on the Space Shuttles *Atlantis* and *Challenger* at KSC.

Charlie Duke

Charlie Duke left the Astronaut Office in December 1975, effective January 1, 1976. He also resigned from active duty with the Air Force. Deciding to join the Air Force Reserves, he served for a time as special assistant to the commander of the U.S. Air Force Recruiting Service, eventually receiving a promotion to brigadier general in 1979. He would resign from the reserve in June 1986, after 30 years of Air Force service.

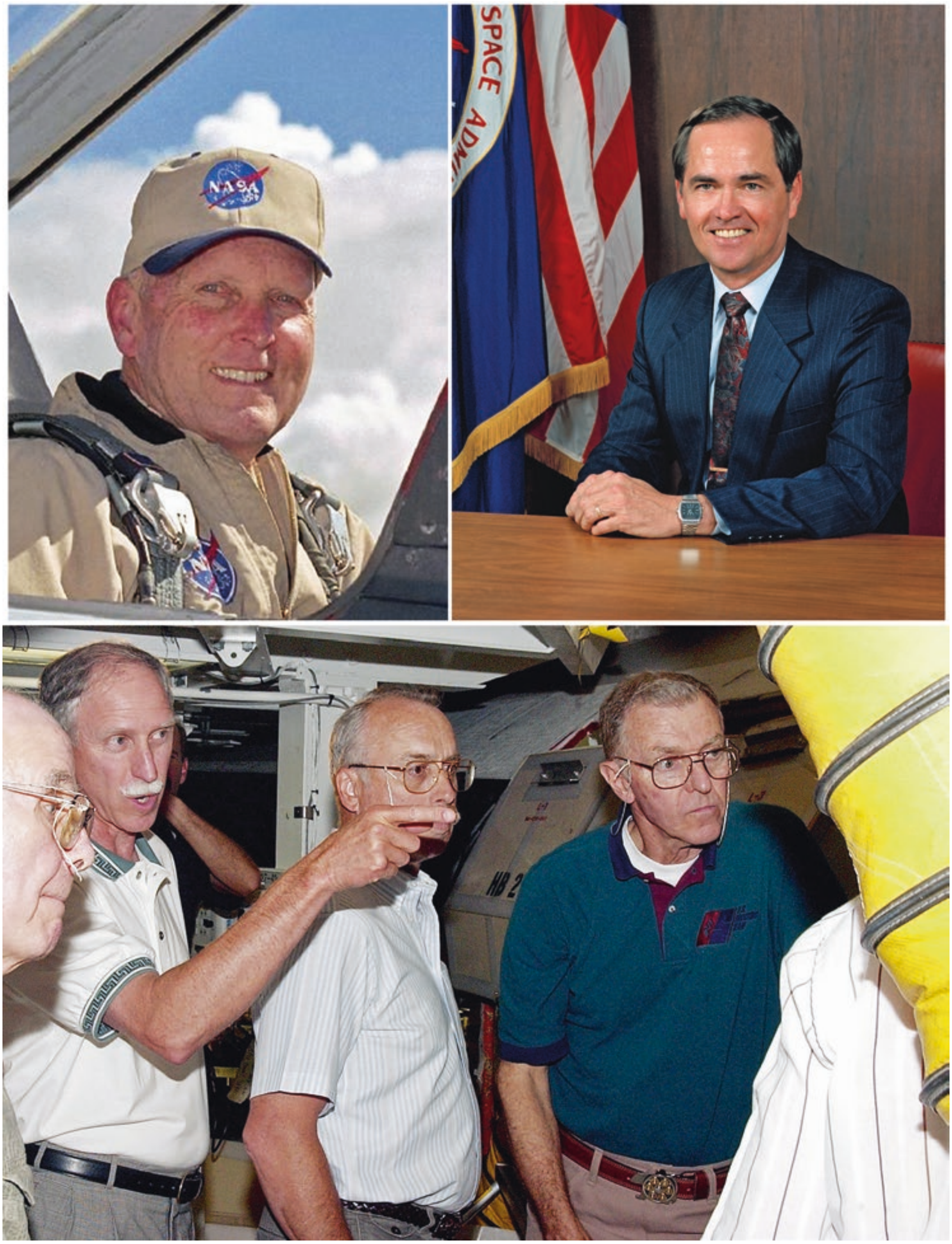
Upon leaving NASA, Duke chose to go into private business, initially becoming a distributor for Coors Beer with the Orbit Corporation in San Antonio, Texas. He resigned from the company in March 1978, before later becoming president of two corporations (including Charlie Duke Enterprises), and a partner in Campbell-Duke Investments, (which he now owns). He was also an active partner in shopping center real estate development.

Duke has been chairman (and remains on the board of directors) of the Astronaut Scholarship Foundation, and was appointed to the NASA Advisory Council. In 1990, he received a second honorary doctorate, this time in Humanities, from Francis Marion College, South Carolina. Today, he remains an active speaker at churches and other gatherings worldwide as part of Project Warrior and, as president of the Duke Ministry for Christ, is a devoted Christian lay witness.

Among numerous honors, Duke has been awarded: the NASA Distinguished Service Medal and the JSC Certificate of Commendation (1970); the Air Force Distinguished Service Medal with Oak Leaf Cluster and Legion of Merit; the Air Force Command Pilot Astronaut Wings; the SETP Iven C. Kincheloe Award of 1972; the AAS Flight Achievement Award for 1972; the AIAA Haley Astronautics Award for 1973; and the *Fédération Aéronautique Internationale* (FAI) V.M. Komarov Diploma in 1973. He was named South Carolina Man of the Year in 1973 and was inducted into the South Carolina Hall of Fame in the same year. He was presented with the Boy Scouts of America Distinguished Eagle Scout Award in 1975 [12] and was inducted into the U.S. Astronaut Hall of Fame on October 4, 1997. Charlie Duke's autobiography, *Moonwalker,* written together with his wife Dottie, was published in 1990.

Joe Engle

Joe Engle retired from NASA on November 28, 1986, and from the USAF two days later. By then, he had flown over 185 different types of airplanes, including 38 different fighter and attack aircraft. He had also logged more than 14,700 flight hours, including 9,900 hours in jets and over 224 hours in space, and held the distinction of being the only person to have flown two entirely different winged space vehicles – the X-15 and the Space Shuttle.



[Top left] Fullerton, NASA Research Pilot, Dryden. [Top right] Crippen, NASA's 5th Director of the Kennedy Space Center. [Bottom] Joe Engle (right) during his term as a member of the post-*Columbia* Stafford-Covey Return-to-Flight Task Group.

Engle subsequently joined the Kansas Air National Guard (ANG) and served during the late 1980s as the ANG assistant to the commander in chief, U.S. Space Command and North American Air Defense Command, with Headquarters at Peterson Air Force Base, Colorado. He achieved the rank of major general before retiring from the ANG in 1991. From the 1990s onward, Engle served as an aerospace engineering consultant and simulation evaluation pilot for Space Shuttle modifications and other advanced piloted re-entry vehicles. He was a technical advisor to NASA's ISS Advisory Committee and was also a consultant spokesman for Bushnell Performance Optics. His devoted wife Mary died in December 2004, and he is now married to Jeanie Carter Engle, of Houston, Texas.

As 'Test Pilot Emeritus' of the USAF Test Pilot School, Joe Engle remained active in flying, including jet fighter aircraft, and today remains an avid outdoor sportsman and wildlife enthusiast. His numerous awards and decorations include: the Distinguished Flying Cross, twice (1964 and 1978); the SETP Iven C. Kincheloe Award (1977); NASA Exceptional Service Medal and Distinguished Service Medal; Goddard Memorial Trophy; Robert J. Collier Trophy; and the Air Force Distinguished Service Medal (1985). He was inducted into the National Aviation Hall of Fame, Dayton, Ohio, and the Astronaut Hall of Fame, Florida (2001) [13]

Ron Evans

After leaving NASA in 1977, Ron Evans worked for the Western American Energy Corporation in Scottsdale, Arizona until 1978, when he joined Sperry Flight Systems in Phoenix, becoming their director for Space Systems marketing. He later formed his own consulting company in the coal industry.

On April 7, 1990, Janet Evans discovered that her husband had died in his sleep of an apparent heart attack at their home in Scottsdale. He was 56 years old. A memorial service for the late aviator-astronaut was conducted four days later at Scottsdale's Valley Presbyterian Church. Evans was survived by his wife Janet, his mother, his brother, and his son and daughter.

The loss of Ron Evans came as a complete shock to Apollo 17 commander Gene Cernan. "My own feeling of invincibility received a large dose of reality in 1990, when Ron Evans died in his sleep," he recalled in his 1999 autobiography. "How could someone who had over one hundred combat missions in Vietnam and had gone to the Moon pass away so easily? One of the most difficult things I ever had to do was deliver the eulogy at his memorial service, but I found comfort in the poem 'High Flight,' knowing that Ron would finally 'reach out and touch the face of God.' He was a special person, with whom I went on the journey of a lifetime." [14]

Gordon Fullerton

Gordon Fullerton never received his third spaceflight seat. In October 1986, he decided to join the Flight Crew Branch of NASA Dryden as a test pilot at Edwards AFB. On July 27, 1988, he retired after a 30-year career with the USAF with the rank of colonel. For several years, he flew as one of the pilots of the Shuttle Carrier Aircraft (SCA), ferrying orbiters from their landing at Edwards AFB to the Kennedy launch site to begin processing for their next mission.

As the project pilot on the NB-52 launch aircraft, Fullerton flew the first six air launches of the commercially-developed Pegasus winged space booster. He was also involved in a series of development air launches of the X-38 Crew Recovery Vehicle and the Pegasus launches for the X-43A Hyper-X advanced propulsion project. He then became the project pilot on the Propulsion Controlled Aircraft program, during which he successfully landed both a modified F-15 and an MD-11 transport with all control surfaces neutralized, using only engine thrust modulation for control. Fullerton also flew Dryden's DC-8 Airborne Science aircraft, regularly deployed worldwide to support a variety of research studies, including atmospheric physics, ground mapping and meteorology. Assigned to evaluate the flying qualities of the Russian Tu-144 supersonic transport during two flights in 1998, becoming one of only two non-Russian pilots to fly the aircraft, he reached a speed of Mach 2. He then led a project that utilized a modified Convair 990 to test Space Shuttle landing gear components during many high-speed landings. In December 2007, Gordon Fullerton retired from NASA and from his post of associate director of Flight Operations at NASA's Dryden Flight Research Center[1].

Among the many special awards and honors Col. Fullerton received were: the SETP Iven C. Kincheloe Award (1978); Air Force Distinguished Flying Cross; NASA Distinguished and Exceptional Service Medals; NASA Space Flight Medals in 1983 and 1985; General Thomas D. White Space Trophy; and the Ray E. Tenhoff Award from the SETP in 1992 and 1993. Fullerton was inducted into the Astronaut Hall of Fame in 2005 and the International Space Hall of Fame in 1982. [15]

Fullerton, his wife Marie, and their two children lived in Lancaster, California. He spent his last few years in a care facility following a stroke in 2009 which left him partially paralyzed, and passed away on August 21, 2013, aged 76. A funeral Mass was held on Saturday, August 24, at the Sacred Heart Catholic Church in Lancaster. He is survived by his wife, Marie, a former Air Force nurse, his son and daughter, five grandchildren and two sisters.

"Gordy was an excellent leader and human being," recalled former STS-51F Mission Specialist (MS) Tony England. "Most of the early military astronauts had built their careers flying single-pilot aircraft. While the challenges they faced were formidable, they really did not need to learn how to lead others. Gordy had been a test pilot in heavy aircraft requiring crews with shared responsibilities. He had both the need and the opportunity to learn to effectively lead others. He learned well. I knew him as someone who quietly ensured that each of his crew members knew their jobs and, once he was confident in their competence, he both trusted them to do their jobs and listened to their recommendations. We all knew that Gordy 'had our back' as we had his. This made for a wonderful working environment. While our flight incurred many challenges, from its 'Abort-to-Orbit,' to deploying and recovering the plasma sensing satellite, to software control issues with the first flight of the Instrument Pointing System, we all systematically went about solving problems without one abrasive comment among us. Not all crews remain friends after their missions. Our crew was unique in that most of us left NASA feeling greater affinity for the crew members of our STS-51F than we did for the Astronaut Office as a whole." [16]

[1] Dryden was renamed the Armstrong Flight Research Center, effective March 1, 2014, in honor of the first man on the Moon, who had passed away in August 2012.

Fellow STS-51F MS Story Musgrave concurred not only with Fullerton's humanity and personality, but also his incredible flying skills, "Gordon was a grand and great human; a loving and affectionate husband and father; an authentic and noble human; a true and faithful Air Force officer; a mindful and masterful pilot; a professional in every sense of the word; one of the best spaceflight commanders that I could imagine; and a dear and loyal colleague and companion. He flew every kind of everything, but it was his exquisite mastery of being a large airplane captain that translated into his being the best of the best spaceflight commanders. He knew how to learn and run large and complex systems and how to get the most out of a large and complex crew, just like a complex and difficult space mission. He was deeply democratic and mindful in his decision making and execution. Mostly he just supported his gang so they could get on with what they had to do. I love you Gordo." [17]

Ed Givens

Ed Givens died from injuries sustained in a road traffic accident in Pearland, Texas, on June 6, 1967, at the age of 37, while on active astronaut duty with NASA and the USAF. Had he not been killed, it is likely he would have been given an assignment as CMP on a later Apollo lunar mission.

Fred Haise

Upon leaving the Astronaut Office in 1979, Fred Haise became vice president for Space Programs with the Grumman Aerospace Corporation in Bethpage, New York. He then became president of Grumman's Space Station Support Division in 1987, and remained with the company until his retirement as president of Northrop Grumman Technical Services (GTS) in 1996.

Today, Haise has four grown children with his first wife Mary Griffin Grant, whom he divorced in 1978. In 1979, he was married for a second time, to the former F. Patt Price of Rogers, Texas, and they now reside in Pasadena, Texas. He is an Associate Fellow of the AIAA, and Fellow of the SETP and the AAS. [21] Among his many awards and honors are: The Presidential Medal of Freedom; the AIAA Haley Astronautics Award; the General Thomas D. White Space Trophy; the SETP Iven C. Kincheloe "Test Pilot of the Year" Award; the NASA Distinguished Service Medal; the NASA Exceptional Service Award; the NASA Special Achievement Award; and the Aerospace Walk of Honor. He was inducted into the U.S. Astronaut Hall of Fame in Titusville, Florida, on October 4, 1997. [18]

As scientist-astronaut and Moonwalker Harrison Schmitt wrote in tribute to the crew of Apollo 13 in 2015: "Among the many debts America, Apollo and science owe to the Apollo 13 crew, there is one that few may remember. Jim [Lovell] and Fred volunteered to take a new approach to training for lunar exploration that combined geological training with operational simulation, on sites that represented some critical geological relationship to their planned landing site of Fra Mauro. Their enthusiasm for this concentrated, once a month, week-long immersion in geology and exploration convinced other crews to adopt the same approach, to the immeasurable benefit of Apollo lunar science. Although circumstances prevented Apollo 13's landing on the Moon, creating an extraordinary mission of endurance and innovation, my geological colleagues and I will forever be grateful to Jim and Fred for showing the way for subsequent lunar exploration training." [19]

Hank Hartsfield

In completing his third and final Shuttle mission, STS-61A in 1985, Hank Hartsfield had circled the Earth a total of 321 times, spending 20 days, 2 hours and 50 minutes in space. Leaving the Astronaut Office shortly afterwards, he subsequently served in several administrative posts within NASA, including deputy chief of the Astronaut Office, deputy director for Flight Crew Operations, and director of the Technical Integration and Analysis Division at NASA Headquarters. He then became deputy manager for operations in the Space Station Operations Office at NASA's Marshall Space Flight Center (MSFC) in Huntsville, Alabama. In 1991, Hartsfield returned to JSC as manager of the Man-Tended Capability Phase, Space Station *Freedom* Program and Operations, until 1993. He then became manager of ISS Independent Assessment, ISS Alpha Program at JSC until 1996, before becoming NASA's director of Independent Assurance for Human Exploration and Development of Space. [20] After resigning from the space agency in 1998, he worked as an executive at the Raytheon Corporation until he retired in 2005.

Col. Hartsfield died aged 81, on July 17, 2014, following complications from earlier back surgery. He was survived by his wife Judy (known as Fran), their eldest daughter, two grandsons, and his brother. Sadly, their younger daughter Keely, who had worked as a contractor to the Space Shuttle program, had died just four months before him, in March

(Left) Fred Haise with Rosemary Roosa, daughter of the late Stu Roosa, beside a 'moon tree' grown from seeds flown on Apollo 14, planted at the INFINITY science center, NASA Stennis Center, Alabama. (Right) Hank Hartsfield, NASA Director of Independent Assurance, Human Exploration and Development of Space.

2014. Tragedy struck the family for a third time later that year, when his wife Fran passed away in Houston on December 21.

Hartsfield's list of special honors and awards includes: Air Force Meritorious Service Medal; General Thomas D. White Space Trophy for 1973 (1974); Alabama Aviation Hall of Fame (1983); Distinguished Civilian Service Award (DOD) (1982); NASA Distinguished Service Medals (1982, 1988); NASA Space Flight Medals (1982, 1984, 1985); NASA Exceptional Service Medal (1988); and an Honorary Doctor of Science degree from Auburn University (1986). Hank Hartsfield was inducted into the U.S. Astronaut Hall of Fame in 2006. [**21**]

Jim Irwin

Jim Irwin retired from the USAF and from NASA on July 1, 1972. He went on to found the non-profit High Flight Foundation in Colorado, allowing him to discuss and debate his religious convictions at speaking engagements and seminars, explaining how they had been enhanced by his trip to the Moon. He also led five annual expeditions to Mount Ararat in Turkey, in an unfulfilled quest to find the remains of the biblical Noah's Ark. During the 1982 expedition, as his group of 14 researchers was ascending Mount Ararat, Irwin was struck by a falling rock and severely injured. He was transported down the mountain by horse and rushed to a local hospital, which had only primitive facilities, but he pulled through. After he had recovered, a determined Irwin mounted fresh expeditions, returning to Mount Ararat in 1983 and 1984. But as before, and to his profound disappointment, he found no evidence or trace of the Ark.

By this time, Irwin had suffered through a history of heart problems and finally succumbed to a massive heart attack on August 8, 1991, twenty years and one day after returning to Earth on Apollo 15. He passed away in the Valley View Hospital in Glenwood Springs, Colorado, at the age of 62. He was buried with full military honors at Arlington National Cemetery a week later. He was the first loss from the twelve men who had set foot on the Moon. Irwin's biography *To Rule the Night*, with William A. Emerson, Jr. was published in 1973. He also authored several children's titles[2].

Irwin was a member of the SETP and a recipient of the USAF Air Force Distinguished Service Medal; two USAF Commendation Medals; NASA Distinguished Service Medal; United Nations Peace Medal, 1971; USAF Association's David C. Schilling Trophy, 1971; Robert J. Collier Trophy, 1971; Haley Astronautics AIAA Award, 1972; and the Kitty Hawk Memorial Award, 1971. He was also awarded an Honorary Doctorate of Astronautical Engineering from the University of Michigan in 1971; an Honorary Doctorate of Science from William Jewell College in 1971; and an Honorary DSc. from Samford University in 1972. Irwin was inducted into the International Space Hall of Fame in 1983, and the U.S. Astronaut Hall of Fame on October 4, 1997. [**22**]

Don Lind

In 1986, Dr. Lind left NASA to join the faculty at Utah State University as a professor of Physics. He was one of the first astronauts to leave the program in the wake of the *Challenger* accident, but had made the decision to retire in November the previous year,

---

[2] As this book was being produced, the authors received an email from astronaut Al Worden giving his thoughts about his Apollo 15 colleague, which needed to be included. See End Note on Page 389.

well before the vehicle on which he flew his only spaceflight was lost, along with her crew of seven.

Whenever Don Lind visits KSC, he looks longingly at the Saturn V rocket on display there. It is the Saturn that might have been his if the Apollo program had continued. "Every time I pass that, I cry," he once told reporters. [23] He expresses the same feelings each time he visits the National Air and Space Museum in Washington D.C. and the displayed Skylab Orbital Workshop, which he might have lived aboard in the mid-1970s had it flown as planned as Skylab B. Lind and his wife Kathleen are the proud parents of seven children and faithful members of their Mormon community. They completed numerous good-will 'missions' for their Church after he left the space program. Once active in the Boy Scouts of America, he earned the rank of Eagle Scout. Don Lind is a member of the American Geophysical Union, the American Association for the Advancement of Science, and Phi Kappa Phi. Lind was awarded the NASA Exceptional Service Medal in 1974. His biography, *Don Lind Mormon Astronaut,* written by his wife, was published shortly after his space flight in 1985.

Jack Lousma

After leaving NASA on October 1, 1983, Col. Jack Lousma resigned from the U.S. Marine Corps the following month (effective November 1, 1983). A brief stint as a politician followed, with Lousma winning Michigan's Republican Senate primary, but losing in the November 1984 general election to Democrat incumbent Carl Levin. He then formed his own high-technology consultancy company and worked with Jerry Carr's company CAMUS on several projects. In September 2013, Jack and Gratia Lousma moved back to Texas after several years in Michigan. Today, they have four children, nine grandchildren and (so far) one great-grandchild.

During his time with NASA, Lousma was awarded the NASA Distinguished Service Medal three separate times, in 1973, 1974 and 1982. Among many other awards and honors, he was also inducted into the U.S. Astronaut Hall of Fame on 4 October 1997.

Ken Mattingly

Having logged just over 508 hours and 24 minutes during his three space missions, Ken Mattingly resigned from NASA in June 1985. He also resigned from the USN with the rank of two-star rear admiral on the same day. He then entered the private sector, initially becoming director of the space program of the Naval Electronic Systems Command in Arlington, Virginia. Mattingly has received numerous awards and honors, including: the NASA Distinguished Service Medal (twice); the Navy Distinguished Service Medal; the SETP Iven C. Kincheloe Award (1972); the AAS Flight Achievement Award for 1972; and the AIAA Haley Astronautics Award for 1973. He also received the Department of Defense Distinguished Service Medal in 1982. Twice married and divorced, he has one son. [24]

Bruce McCandless

On August 31, 1990, four months after flying on the mission to deploy the Hubble Space Telescope in orbit, Bruce McCandless II retired from NASA and the Navy, having served more than 24 years as an astronaut and more than 32 years with the USN. After leaving NASA, McCandless worked at the Martin Marietta Corporation and was a senior research scientist at Lockheed Martin Space Systems in Littleton, Colorado. He also served as a consultant on STS-61, NASA's first Hubble Servicing Mission flown in December 1993. Over the course of his service to his country and NASA, he has deservedly received a host of awards and honors. Most notable are the Legion of Merit (1988) and the Department of Defense Distinguished Service Medal (1985). Sadly, his wife of 53 years, Bernice McCandless, passed away on January 14, 2014, aged 76, after a valiant fight against breast cancer.

Ed Mitchell

On October 1, 1972, less than two years after reaching the Moon on Apollo 14, Mitchell resigned from NASA and the USN. In January 1973, he founded the Institute of Noetic Sciences in Palo Alto, California, specifically formed to study and test psychic phenomena, and which he chaired until 1982. From 1974 to 1978, he was president of Edgar Mitchell Corporation (EMCO) in Palm Beach, Florida. He later became the first chairman of Eternea Inc., in Florida, a research organization dedicated to understanding consciousness.

Mitchell was never shy about expounding his belief that there is life on other planets, and was convinced that some of those extraterrestrial wanderers have visited Earth. Asked about the idea of a government cover-up of UFOs in 2004, he exclaimed, "That's putting it mildly." He said if the public knew what he claimed the government was hiding, "it would rattle our foundations." [25]

Mitchell spent his later years living off his naval pension, income from lectures, and royalties from his books, including *Psychic Exploration: A Challenge for Science* (1974) and *Way of the Explorer* (1996). In both titles, he tried to convey what he had learned while looking back at the Earth; in the latter, his dissatisfaction with the state of the world, and a compulsion to do something about it. "From out there on the Moon, international politics look so petty. You want to grab a politician by the scruff of the neck and drag him a quarter of a million miles out and say, 'Look at that, you son of a bitch'." [26] A children's title, *Earth Rise: My Adventures as an Apollo 14 Astronaut*, was published in 2014.

As well as receiving the Presidential Medal of Freedom in 1970, Ed Mitchell received several honorary engineering and science degrees; from New Mexico State University (1970), Carnegie Mellon University (1971), University of Akron (1979), and Embry-Riddle University (1996). He was married three times. Following his divorce from the former Louise Randall, he wed Anita Mitchell in 1972 and adopted her three children. The couple separated in 1984 and five years later, he married Sheilah Ledbetter, a former Playboy model. They were divorced in 1999.

Moonwalker Edgar Mitchell died on February 4, 2016 in West Palm Beach, aged 85. He is survived by five children, as well as nine grandchildren and one great-grandchild. One son predeceased him in 2010. [27]

Bob Overmyer

Following his retirement from both NASA and the USMC in May 1986, Bob Overmyer set up his own consulting business, Mach 25 International, Inc. He also consulted to major aerospace corporations and the National Broadcasting Corporation (NBC) and was a guest contributor to the UK space magazine *Spaceflight News*. In March 1988, as well as continuing his career as a general aviation test pilot, Overmyer joined the Space Station team at McDonnell Douglas Aerospace, where he led crew and operations activities for seven years. [28]

Col. Overmyer died on Friday afternoon, March 22, 1996, when the experimental VK30 prototype aircraft he was test-flying crashed near Duluth, Minnesota. He was the only person aboard the five-seat plane, which came down in a snowy, wooded area about six miles north of Duluth International Airport after it had stalled and gone into a spin. He was 59 years old.

His daughter Carolyn, who often flew with her father, said he was wearing a parachute at the time and had tried to bail out. "He was doing full-flap stalls at 8,000 feet and the plane turned over and went into a spin. I guess he had the door open, but he couldn't get out. He was in full pilot gear. He was obviously trying to escape." Carolyn was given that information by the Duluth aviation firm, Cirrus Design Corporation, which had contracted Overmyer in November 1995 for test pilot services. "I'm sure he had meticulously done his job, and the plane just didn't cooperate," she added. "He loved to fly, and he loved being a test pilot. He loved pushing the envelope; but he didn't take any unnecessary risks." [29] Col. Overmyer left behind his wife, Katherine (Kit), and three children.

Among his many awards and honors, Overmyer received: the U.S. Air Force Meritorious Service Medal in 1969 for duties with the USAF Manned Orbiting Laboratory (MOL) program; an Honorary Doctor of Philosophy degree from Baldwin Wallace College, December 1982; the Distinguished Flying Cross (1983); and the NASA Space Flight Medal (1983). Overmyer was a member of the SETP, the Experimental Aircraft Association, and the Aircraft Owners and Pilots Association. [30]

Don Peterson

Don Peterson would not fly into space again after STS-6. He resigned from NASA in December 1984 to become an aerospace industry consultant in the Houston area. "Basically, I did the same kind of things as a consultant that I had done as an astronaut," he told a NASA interviewer in 2002. "I worked for several different companies, and I worked on things like crew interfaces and crew procedures and habitability; that is, all the things you put on a spacecraft so people can live there and be reasonably comfortable… I worked for Grumman [Aerospace Corporation] when they were on Long Island from about early '85 through '92." [31] Don Peterson has been married to the former Bonnie Love of Coffeeville, Mississippi, since September 1957, and they have three children. Among other honors, he has been awarded the Air Force Commendation Medal, the Meritorious Service Medal, and the JSC Group Achievement Award (1972).

Bill Pogue

Col. William R. Pogue retired from both the USAF and NASA on September 1, 1975, to pursue a career as an independent aerospace consultant, working with the Department of Energy and the Public Service Company of Oklahoma. He also took on the role of vice president of the Colorado Springs-based High Flight Foundation, the religious organization founded by fellow astronaut Jim Irwin. Additionally, Pogue became an adjunct professor at the University of Arkansas and carried out technical work for the Martin Marietta Corporation (now Lockheed Martin), in support of the space systems division of Air Force Systems Command.

Working with Jerry Carr's CAMUS Company from 1984 to 1998, Pogue gave technical support to the Boeing Company for Space Station *Freedom* (which later evolved into the ISS), utilizing his experience of Skylab to evaluate mock-ups and familiarize workers with the effects of microgravity on crews and equipment. He also performed liaison work with NASA at JSC for spacewalks to assemble the space station. [32]

In addition to being a popular and accomplished public speaker, Pogue was also the author of five books. The first, published in 1985, was called *Astronaut Primer*, and the same year his self-explanatory book, *How Do You Go to the Bathroom in Space? All the Answers to All the Questions You Have About Living in Space*, was also released. In 1992, he teamed with author Ben Bova to produce the science fiction novel, *The Trikon Deception,* and in 2003 he wrote a second book of questions and answers called *Space Trivia*. His book, *But for the Grace of God: An Autobiography of an Aviator and Astronaut*, was published and released in 2011.

Some of the honors and awards Pogue received include: The NASA Distinguished Service Medal (1974); Air Force Commendation Medal; the National Defense Service Medal; an Outstanding Unit Citation (while a member of the USAF Thunderbirds); the Air Force Distinguished Service Medal; the Robert J. Collier Trophy for 1973 (1974); the Robert H. Goddard Memorial Trophy for 1975 (1975); the General Thomas D. White U.S. Air Force Space Trophy for 1974 (1975); the AIAA Haley Astronautics Award for 1974 (1975); the AAS 1975 Flight Achievement Award (1976); and inductee, the Oklahoma Aviation and Space Hall of Fame (1980). In October 1997, Col. Pogue was inducted into the U.S. Astronaut Hall of Fame in Titusville, Florida. [33] In 1975, Sand Springs municipal airport was renamed William R. Pogue Airport to honor the Skylab 4 astronaut who had grown up in that area.

Bill Pogue died of natural causes aged 84, on March 3, 2014, at his home in Cocoa Beach, Florida. He is survived by his third wife Tina, three children from his first marriage to Helen Juanita Dittmar, and four stepchildren from his second marriage to Jean Ann Baird. He was predeceased by his first and second wives.

"Bill was a friend, a dependable friend, who I've always greatly admired," former scientist astronaut Ed Gibson recalled. "He was skilled, humorous, but most characteristically, full of determination to always tirelessly press forward at full speed in the right direction. Along with Jerry, Bill was scheduled to go to the Moon on Apollo 19. Who wouldn't be excited at that prospect? But when it was cancelled, they both moved on to Skylab with determination to make THAT the best mission ever.

"Bill designed our mission patch. Each Skylab crew designed theirs using 1-4. Then [they were] told they should use 1-3 and Bill redid ours. Was that roman numerals or Arabic? Then HQ said no, we should use 1-4. Bill reversed field again. Then, once HQ found out that all the flight suits had already had 1, 2 or 3 on them, Bill went back to the previous, previous one. Throughout it all we were in training for the mission. With his usual high spirits and determination, Bill just said, "Hey, we have a patch for every occasion.

"A few weeks before launch, an inspector found cracks in all eight fins at the tail of our booster. The pad maintenance crew had to start working around the clock to replace the fins. I suggested calling the booster, '*Humpty Dumpty*,' [and] Bill and Jerry got a laugh out of it but the stressed pad manager was not amused. An hour before launch, we began receiving good-luck messages from teams that had worked on the spacecraft and booster. The last one was from the pad manager who, once the job was complete, had reacquired his sense of humor, 'Good luck and Godspeed from all the king's horses and all the king's men.' That message really broke us up.

"Being the pilot on our mission, Bill did much of the repair of our systems. One job required a long hose. However, being on the last mission, the hose, like so many other items, wasn't where it was supposed to be. Ground had no idea where it was, so they contacted Jack Lousma who last used it and now was out mowing his lawn. Jack had no idea. Finally, an alternate approach was devised and the job completed. It took only 5 times longer than planned and put Bill through the wringer one more time. Bill just pressed on as he always did with his steady determination.

"Bill and I had a task on a spacewalk to repair an antenna. No problem … except that it was on the side of Skylab where we were never planned to go so there were no hand holds or foot restraints. Also, we had to remove a top on a box held down by screws that were nearly completely covered, a condition not present on the training mockup. So, with me awkwardly braced and holding his feet, Bill used his bulky gloves to insert a small screwdriver into the slots of many screws – from the side. We traded places several times. We had no TV, so ground control had no idea what these two rubberneckers were doing up there except it was taking an hour or so longer than planned. I believe it was one of the hardest tasks ever done on a spacewalk. But when I looked into Bill's face, his blue eyes bulging with determination, I knew we'd make it happen. Sure enough, many blue fingernails later, we did. His grit and willpower in that tough situation has always remained with me.

"I also admired Bill because he was once a Thunderbird pilot. I once asked him if it was difficult. Characteristically he replied, "Naw, not really, *just* a lot of hard work." Bill was a gentleman, true friend and, to use a $10 word, indefatigable. The world is a better place because Bill was in it!" [**34**]

Stu Roosa

Shortly after being assigned to the fledgling Space Shuttle program, Col. Stuart Allen Roosa finally resigned from NASA and the USAF, on February 1, 1976. After completing a course in advanced management at Harvard Business School, he became corporate vice president for International Operations with U.S. Industries in Illinois, and later president of the U.S. Industries Middle East Development Company in Athens, Greece. On his return to the United States, he worked in several executive positions and in property development, before becoming president and owner of a Coors Beer distributorship in Gulfport, Mississippi, in 1981.

Col. Roosa died in Washington, D.C., on December 12, 1994, during a visit with one of his children. His death at the age of 61 was attributed to complications from pancreatitis. He was buried at Arlington National Cemetery and was survived by his wife Joan (who died on October 30, 2007), their three sons, their daughter and two granddaughters.

Roosa's special honors include: the NASA Distinguished Service Medal; the JSC Superior Achievement Award (1970); the Air Force Distinguished Service Medal; and the AAS Flight Achievement Award (1971). He also earned a professional master's degree (PMD) from Harvard Business School in Cambridge, Massachusetts, and a Doctor of Law degree (LLD) from St. Thomas University in Houston. Roosa was also a member of the SETP, the Association of Space Explorers, the Explorers Club, the Circumnavigators Club, the Shikar Safari Club, and the Confederate Air Force.

In February 2005, to mark the 24th anniversary of the return of the Apollo 14 crew from the Moon, the Roosa family gathered once again at Arlington National Cemetery. They were there to plant a tree grown from one of nearly 500 seeds that Roosa had packed into his personal kit for the flight. He had seen this as a tribute to his days in Oregon as a smoke jumper. Today, "Moon trees" (as they are known) grown from these seeds – sycamores, Douglas firs, loblolly pines, sweet gums and redwoods – adorn lawns around the world, from the White House to Japan. [35] In 2011, Willie G. Moseley wrote the book *Smoke Jumper, Moon Pilot, The Remarkable Life of Apollo 14 Astronaut Stuart Roosa.*

Jack Swigert

Jack Swigert took a leave of absence from NASA in 1973 to become the executive director of the Committee on Science and Technology of the U.S. House of Representatives, a position he held until August 31, 1977, when he officially resigned from both the committee and NASA. He had been offered a chance to return to the space agency as a Space Shuttle pilot but declined.

Following forays into the private sector, Swigert decided to make a run for the Senate. However, he lost in the Republican primary to Bill Armstrong in his first attempt at election, and instead became vice-president of the BDM Corporation in Colorado in 1979. Two years later, he left BDM and joined International Gold and Minerals as vice president for Financial and Corporate Affairs. Undeterred in his political ambitions, he then became a Republican candidate for the House of Representatives in February 1982 and was elected in November that year with 62 percent of the popular vote. A campaign supporter once described him as "a potent advocate for Ronald Reagan, a certified hero with a brain."

In June 1982, however, Swigert had undergone surgery and received radiation treatment for a malignant tumor in his right nasal passage, but learned that the cancer had spread to his bone marrow and lungs three months later. He held news conferences to disclose the cancer's development and began broadcasting a 30-second campaign announcement on Denver television stations in the fall, in which he said, in part, "I was privileged to be one of the few who viewed our Earth from the Moon, and that vision taught me that technology and commitment can overcome any challenge." A week before he died, Swigert was flown from his home in Littleton, Colorado, to the cancer center at Georgetown University Hospital in Washington, where he died of respiratory failure on December 27, aged 51, just eight days before he would have been sworn into office.

Following his death, Swigert had several education centers named after him. He was inducted into the Colorado Aviation Hall of Fame in 1988 and the U.S. Astronaut Hall of Fame in October 1997. In 2004, the Space Foundation launched the John "Jack" Swigert Award for Space Exploration, which recognizes extraordinary accomplishment by a company, space agency or consortium of organizations in the realm of space exploration and discovery. Among his numerous other honors, Swigert was presented the Presidential Medal for Freedom in 1970 and the NASA Distinguished Service Medal. He was co-recipient of the AAS Flight Achievement Award for 1970, the AIAA Haley Astronautics Award for 1971, and the AIAA Octave Chanute Award for 1966 (for his participation in demonstrating the Rogallo Wing as a feasible land landing system for returning space vehicles and astronauts). He also received Colorado University's Distinguished Alumnus Award in 1970. Duplicate statues of Jack Swigert, in his space suit, were erected in the U.S. Capitol Visitor Center, and the Concourse B train platform at Colorado's Denver International Airport. [**36**]

As scientist astronaut and Moonwalker Harrison Schmitt stated in his 2015 tribute to the Apollo 13 crew: "Jack Swigert's presence in memory and history will remain forever. Jack's remarkable performance in the role of Apollo 13's Command Module Pilot, with almost no warning that he would be flying that mission, left a unique mark in its own right in the history of Apollo. His astronaut selection group 5 and my group 4 trained together prior to our backup crew assignments. Our work on creating spacecraft malfunction procedures gave me a great opportunity to watch a talented engineer and pilot in action. As we were two of the three astronaut bachelors at the time, you can imagine that there are many stories better left untold… After Jack's outstanding election victory to the United States House of Representatives for Colorado's 6th District, we almost joined up again in politics, but that was not to be. Jack would have joined John Glenn and me as the third astronaut to have served in Congress." [**19**]

Dick Truly

In October 1983, barely a month after completing his second spaceflight as Commander of STS-8, Dick Truly left NASA to become the first commander of the Naval Space Command in Dahlgren, Virginia. On February 20, 1986, just three weeks after the *Challenger* disaster, Truly returned to NASA to become the space agency's Associate Administrator of Space Flight. His primary task was to preside over the *Challenger* accident investigation and the Space Shuttle's eventual return to flight.

After more than 30 years of service, Vice Adm. Truly retired from the U.S. Navy on June 16, 1989. The previous month, he had been appointed as NASA's eighth administrator, a position he held until April 1992. After his second departure from NASA, he led the Georgia Tech Research Institute from 1992 to 1997 and the National Renewable Energy Laboratory from 1997 to 2005. He also served on the board of directors of the Space Foundation from 2003 to 2009.

On January 18, 1989, Truly was awarded the Presidential Citizen's Medal by President Ronald Reagan. His NASA awards include: two NASA Distinguished Service Medals; the NASA Outstanding Leadership Medal; two NASA Exceptional Service Medals; and two NASA Space Flight Medals. His military decorations include: the Defense Distinguished Service Medal; the Defense Superior Service Medal; two Legion of Merit awards; the Navy Distinguished Flying Cross; and the Meritorious Service Medal.

NASA's 8th Administrator Richard H. Truly, the first former astronaut to hold the position.

Truly has also received: the Robert J. Collier Trophy twice (1982 and 1989); the Robert H. Goddard Memorial Trophy twice (1982 and 1989); the SETP Iven C. Kincheloe Award (1978) and James H. Doolittle Award (1988); the FAI Gold Space Medal (1984); the Harmon International Trophy (1982); the Thomas D. White Space Trophy (1982); the AIAA Haley Space Flight Award (1980); the AAS Flight Achievement Award (1977) and John F. Kennedy Astronautics Award (1990). He was inducted into the U.S. Astronaut Hall of Fame on November 10, 2001. In addition to their three children, Truly and his wife Cody now have five grandchildren and four great-grandchildren. [37]

Paul Weitz

Paul Weitz retired from the space agency in May 1994. He decided not to pursue the normal avenue for ex-astronauts and enter the corporate world but instead fully retired, to spend time with his family after forty years of government service in the USN and NASA. One of his passions is fishing and he has continued to devote his time to the pursuit of this sport around the world.

Among his many awards and honors, Weitz has received: the NASA Distinguished Service Medal; the Navy Distinguished Service Medal; the Air Medal (5 times) and Commendation Medal (for combat flights in Vietnam); the Robert J. Collier Trophy for 1973 (1974); the AIAA Haley Astronautics Award for 1974; the Robert H. Goddard Memorial Trophy for 1975; the 1974 Harmon International Aviation Trophy for Astronauts (1975); NASA Space Flight Medal (1983); and the Harmon International Award (1989). [38] Weitz was inducted into the U.S. Astronaut Hall of Fame on October 4, 1997.

Al Worden

Al Worden was divorced from his first wife Pamela in December 1969, just before he was selected to fly on Apollo 15. His second marriage was to the former Sandra Lee Wilder in September 1974, but that marriage also ended in divorce in January 1980. He subsequently married Jill Lee Hotchkiss in July 1982. She passed away on May 4, 2014.

From 1972 to 1973, Worden was employed as a senior aerospace scientist at the NASA Ames Research Center in Moffett Field, California, and from 1973 to 1975 he was chief of their Systems Studies Division. After quitting NASA and taking his retirement from active duty with the Air Force in 1975, Worden became president of Maris Worden Aerospace, and vice president of B.F. Goodrich Aerospace in Brecksville, Ohio, in addition to other positions within the aerospace and aviation industries. He was president of Alfred M. Worden, Inc., then director of Energy Management Programs at the Northwood Institute in Midland, Michigan. Later, he was also vice president of Jim Irwin's High Flight Foundation in Colorado Springs. He also served a term as chairman of the board for the Astronaut Scholarship Foundation in Florida.

His post-NASA literary efforts include a book of poetry, *Hello Earth; Greetings from Endeavour* (1974), a children's book, *I Want to Know About a Flight to the Moon* (1974), and a book he has said is a definite pinnacle of his life, *Falling to Earth: An Apollo 15 Astronaut's Journey to the Moon*, written with co-author Francis French (2011).

In 1971, Worden received an honorary doctorate in Astronautical Science from the University of Michigan. His other decorations and awards include: the Distinguished Service Medal; NASA Distinguished Service Medal (1971); Air Force Association David C. Schilling Award (1971); Robert J. Collier Trophy (1971); Kitty Hawk Memorial Award (1971); and AIAA Haley Astronautics Award (1972). He was inducted into the U.S. Astronaut Hall of Fame on October 4, 1997. During a ceremony held in the Apollo V Center at NASA KSC on July 30, 2009, the agency honored Al Worden with an Ambassador of Exploration Award for his many contributions to the U.S. space program. [**39**]

SUMMARY

Apart from Ed Givens, who was tragically killed in a road accident, and John Bull, who reluctantly resigned from the astronaut corps after being diagnosed with a pulmonary disease, all of NASA's Group 5 astronauts continued to serve the space agency with great expertise and distinction. In all, nine members of the "Original 19" flew on missions to the Moon, and history records that three of those nine were assigned as Lunar Module Pilots who landed, and walked, on the lunar surface. Others would fly on later Skylab missions, and several patiently stayed with NASA and eventually flew on the Space Shuttle – five of them in command of vital early missions in that program.

NASA's Group 7 selection of ex-MOL pilots would prove to be the final intake of astronauts for the 1960s, and indeed the last group consisting solely of pilot-astronauts. The MOL seven transferred into NASA's Astronaut Office in the knowledge that there would be no flight seats available for perhaps several years. This would prove to be the case, but eventually all of them would make it into space.

Throughout the long wait for their first missions, all seven members of NASA's Group 7 astronauts (who were never formally endowed with a collective nickname, though they were sometimes known as 'the MOL Guys') would play important roles in the evolution and development of the Space Shuttle program. While they knew there was little or no hope of being assigned to an Apollo or Skylab mission, several of them soon received non-flying support assignments for Apollo, and later all seven were involved in support assignments for Skylab and the Apollo-Soyuz Test Project mission. Two of them, 'Bo' Bobko and Bob Crippen, also took part in the Skylab Medical Experiment Altitude Test (SMEAT). Gordon Fullerton and Richard Truly would later participate as pilots in the Approach and Landing Tests of prototype Shuttle *Enterprise*, with two members of Group 5, Fred Haise and Joe Engle, in command. All seven of the former MOL group first flew on the Space Shuttle. Six of them flew as pilots on early Shuttle orbital missions, and would command their remaining flights into space. Altogether, the 'MOL Guys' would complete 17 Space Shuttle missions.

The contribution of all members of both groups to several NASA programs and spaceflights, including the formative years of creating the ISS, is a proud and enduring record of patience, persistence and achievement. As the last of the space agency's pilot astronauts of the late 1960s, they will forever stand tall in history for their many accomplishments. That they enjoyed the experience of being an astronaut and viewing the Earth from space – despite a wait of a great many years – is undeniable. As Bob Crippen said after the very first Space Shuttle mission – and his first space flight – aboard *Columbia* on April 12, 1981: "The powered flight took a total of about eight and a half minutes. It seemed to me it had gone by in a flash. We had gone from sitting still on the launch pad at the Kennedy Space Center to traveling at 17,500 miles an hour in that eight and a half minutes. It is still mindboggling to me. I recall making some statement on the air-to-ground radio for the benefit of my fellow astronauts, who had also been in the program a long time, that it was well worth the wait."

And so it proved to be.

References

1. Wikipedia online encyclopedia entry, *Karol J. Bobko*, available online at: https://en.wikipedia.org/wiki/Karol_J._Bobko, last accessed, June 15, 2016
2. ***Deke! U.S. Manned Space: From Mercury to the Shuttle***, Donald K. Slayton & Michael Cassutt, Forge Books, New York, 1994, p. 2122
3. Email from Scott Bull to author Colin Burgess, July 29, 2011
4. Outline supplied to author Colin Burgess by Joseph J. Totah, NASA Ames, August 27, 2011
5. Email message relayed to author Colin Burgess by Francis French from Alfred M. Worden, August 9, 2011
6. Email from Dave Anderson to author Colin Burgess, July 20, 2013
7. NASA Biographical Data, *Astronaut John Sumter Bull, PhD*, December 2008
8. *San Jose Mercury News*, John S. Bull obituary, August 29, 2008

9. Wikipedia online encyclopedia entry, *Robert L. Crippen*, available at: *https://en.wikipedia.org/wiki/Robert_Crippen*, last accessed, June 10, 2016
10. NASA JSC Biographical Data, *Robert L. Crippen*. Available online at: *http://www.jsc.nasa.gov/Bios/htmlbios/crippen-rl.html*, last accessed, June 10, 2016
11. New Mexico Museum of Space History, International Space Hall of Fame, Robert L. Crippen, Inducted in 1991. Available online at: *http://www.nmspacemuseum.org/halloffame/detail.php?id=107* Last accessed, June 10, 2016
12. Wikipedia online entry, *Charles Duke*, available at: *https://en.wikipedia.org/wiki/Charles_Duke*, last accessed June 12, 2016
13. Wikipedia online entry*, Joe Engle*, available at: *https://en.wikipedia.org/wiki/Joe_Engle,* last accessed June 14, 2016
14. ***The Last Man on the Moon***, Eugene Cernan with Don Davis, St. Martin's Press, New York, NY, 1999, p. 345
15. NASA Biographical Data, Col. C. Gordon Fullerton, USAF (Ret.), August 2013
16. Email from Tony England to author David J. Shayler, September 20, 2016
17. Email from Story Musgrave to author David J. Shayler, November 5, 2016
18. Wikipedia online encyclopedia, *Fred W. Haise, Jr.* Available at: *https://en.wikipedia.org/wiki/Fred_Haise*, last accessed June 16, 2016
19. Harrison Schmitt tribute, 45th anniversary of Apollo 13 function, San Diego Air & Space Museum, California, March 21, 2015
20. NASA News Release, J14-005, July 18, 2014
21. Wikipedia online entry, *Henry Hartsfield*, available at: *https://en.wikipedia.org/wiki/Henry_Hartsfield,* last accessed June 14, 2016
22. Wikipedia online entry, *James B. Irwin*, available at: *https://en.wikipedia.org/wiki/James_Irwin,* last accessed June 18, 2016
23. *Shuttle Flight is Lind's First Mission*, J. Michael Kennedy, the *Los Angeles Times* newspaper, April 29, 1985
24. ***Men and Women of Space***, Douglas B. Hawthorne, Univelt, Inc. Publishers, San Diego, California, 1992
25. *Highlights in a Great Life: Edgar D. Mitchell, Lunar Module Pilot*, Eternea, Inc. newsletter, February 2016
26. ***The Way of the Explorer***, Edgar D. Mitchell and Dwight Williams, G.P. Putnam and Sons, New York, NY, 1996
27. *Ed Mitchell, 85, one of 12 Moon walkers, dies in West Palm Beach*, Eliot Kleinberg, *Palm Beach Post* newspaper, February 5, 2016
28. NASA Biographical Data, *Robert F. Overmyer (Colonel, USMC, Ret.)*, NASA JSC, Houston, Texas, August 1996
29. *Crash Kills Ex-Shuttle Commander*, the *Allegheny Times* newspaper, Pennsylvania, March 24, 1996, p. A4
30. Wikipedia online entry, *Robert Overmyer*, available at: *https://en.wikipedia.org/wiki/Robert Overmyer,* last accessed June 18, 2016
31. Donald H. Peterson: interview by Jennifer Ross-Nazzal for NASA's Oral History Project, Houston, Texas, November 14, 2002
32. Robert Pearlman, founder, collectSPACE.com website, available online at: *http://www.collectspace.com/news/news-030414a-astronaut-william-pogue-obituary.html*, last accessed July 1. 2016

33. Wikipedia online encyclopedia entry, *William R. Pogue*, available at: *https://en.wikipedia.org/wiki/William_R._Pogue*, last accessed July 1, 2016
34. Email from Ed Gibson to author David J. Shayler, December 31, 2015
35. ***Apollo Moon Missions: The Unsung Heroes***, Billy Watkins, University of Nebraska Press, Lincoln, NE, 2007
36. Wikipedia online encyclopedia entry, *John Swigert*, available at: *https://en.wikipedia.org/wiki/John_Swigert*, last accessed July 1, 2016
37. NASA JSC Biographical Data, *Richard H. Truly, Vice Admiral, USN (Ret.)*, March 1992
38. NASA JSC Biographical Data, *Paul J. Weitz*, Houston, Texas, July 1996
39. Wikipedia online encyclopedia, entry *Alfred Worden*, available at: *https://en.wikipedia.org/wiki/Alfred_Worden*

End Note

"Jim Irwin was not just a Group 5 NASA astronaut, he was also my office mate and my very good personal friend," recalled Apollo 15 CM Pilot Al Worden in 2017. "He was a quiet and thoughtful guy, who never raised his voice and always fell in line with the current thinking of our commander. I used to tell Jim that he should be more assertive about the things he believed in, including procedures to be used on Apollo 15. Jim was a follower, and that was the right thing for him as he was the Lunar Module Pilot of 15, which meant he was the systems engineer for both the Command Module on the way to and from the Moon, and as co-pilot to Dave Scott in the Lunar Module on it's way to the lunar surface at Hadley Rille. Jim was a flawless complement to Dave and did his job superbly. I had known Jim since we were selected for the space program, and I got to know him like a brother. He was always easy to work with because he did his job in a very quiet and professional way.

"Jim and I shared an office for many years while training for our flight, although I did not see him a lot because he worked with the Lunar Module people at Grumman in New York and I worked with the Command Module manufacturer in California. But we did hours of geology training together and traveled extensively to study geology at various sites around the world. He became the consummate geologist along with Dave Scott, our Commander. In fact, it was Jim who found the Genesis rock while exploring the surface around Hadley Rille on the Moon.

"After he left the program and formed his Christian Fellowship organization called 'High Flight', he traveled around the world giving testimony with the help of his pastor from the Baptist Church in Houston, and he became an ordained minister during that time. "Jim was such an outstanding and sociable person that all who knew him loved him. He led a very active and meaningful life both during the space program and during his time with 'High Flight'."

Afterword

The last half of the 20th century was a progressive period in mankind's history. The first launch of a satellite into space occurred in 1957, the first human traveled into Earth orbit in 1961, and the first lunar landing on the Moon by humans occurred in 1969. The Soviet Union was the first country to place an unmanned satellite and a human being into orbit, and Americans were the first to walk on the Moon. In the United States, the lunar landing program was funded despite the great financial burden of the Vietnam War and the Cold War which were then in progress. The first space accomplishments were quickly followed by the voyages of robotic spacecraft to various planets in the solar system, the establishment of space stations in Earth orbit, and the development of the Space Shuttle, a manned orbiting spacecraft with airplane-like wings.

Hindsight says that there was a convergence of conditions in the U.S. that made the first voyages of humans to the Moon possible. These included the ongoing space race with the USSR, a relatively healthy economy, the maturing of appropriate technology, and sufficient political support from the American public and political establishment. The timing of the Apollo, Skylab, and the Space Shuttle programs was fortuitous for members of the astronaut groups 5 and 7, all of whom were born in the 1930s and were pilots.

Astronaut Group 5, which was selected in 1966, consisted of 19 fighter pilots, research pilots, and test pilots from the Air Force, Navy, Marine Corps, NASA, and two aerospace companies. Members of Group 5 jokingly referred to themselves as "The Original 19," which was a tongue-in-cheek comparison to the first group of U.S. astronauts, the "Original 7." NASA presumably selected members of Group 5 because they had more technical education and experience in front-line military aircraft than the average pilot. For example, the most educated, Ed Mitchell, had a Doctor of Science degree and research experience in the field of Aeronautics and Astronautics from MIT. The most experienced pilot was Joe Engle, already an X-15 astronaut, who had piloted the suborbital research vehicle several times to exceedingly high Mach Numbers and altitudes at Edwards AFB in the early 1970s.

D.J. Shayler, C. Burgess, *The Last of NASA's Original Pilot Astronauts*,
Springer Praxis Books, DOI 10.1007/978-3-319-51014-9

After becoming astronauts, there were opportunities for members of Group 5 to show their knowledge, experience, and leadership credentials. For example, Jack Swigert improved his standing as an Apollo 7 support crewman by leading an effort to develop malfunction procedures for the Apollo astronaut crews and mission control. Fred Haise demonstrated commendable informal leadership of the Grumman Lunar Module development team at that contractor's plant in Bethpage, NY.

Unfortunately, early in the Apollo program there was attrition in Group 5. Ed Givens was killed in an automobile accident near Houston in 1967, and John Bull contracted a pulmonary disease that forced his retirement from the astronaut corps – but not from NASA.

Group 7 came into NASA in a different way. NASA received Group 7 from the military services after cancellation of the Air Force Manned Orbiting Laboratory (MOL) program in 1969. The group consisted of 4 Air Force, 1 Marine Corps, and 2 Navy pilots. They all transferred from the MOL program to the Astronaut Office at NASA's Manned Space Center (MSC) in Houston, TX. Each was a graduate of the Air Force Aerospace Research Pilot School (ARPS) at Edwards Air Force Base, which in the early 1970s was commanded by Colonel Chuck Yeager, a former combat and flight research pilot who had been the first to exceed the speed of sound in an aircraft. The MOL program had probably intended to assign Navy officers Dick Truly and Bob Crippen to the fourth MOL manned orbital mission before program cancellation, but unfortunately the demise of MOL came before that mission could launch. All of the MOL astronauts were operational and research pilots and had been involved in MOL program development work.

Members of Group 5 participated extensively in the Apollo, Skylab, and Apollo-Soyuz programs. Fred Haise and Ken Mattingly were the first in Group 5 to be assigned a space mission. That mission was Apollo 13, but a weird thing happened. Backup crewman Swigert replaced Mattingly just 72 hours before launch after the NASA medics believed that Mattingly had been exposed to the German measles, so Swigert and Haise were the ones who actually flew on Apollo 13.

Stu Roosa, Ed Mitchell, Al Worden, Jim Irwin, Ken Mattingly, Charlie Duke, and Ron Evans eventually flew to the Moon on later Apollo flights. Mitchell was the first person from Group 5 to walk on the Moon; Irwin and Duke followed as Moonwalkers on Apollo 15 and 16. On Apollo 15, Irwin was the first from Group 5 to ride the Lunar Roving Vehicle (LRV) on the lunar surface, and Worden was the first to perform an EVA (spacewalk) in cis-lunar space during Apollo 15's return from the Moon. Paul Weitz flew on the first Skylab manned flight, SL-2; Jack Lousma and then Jerry Carr and Bill Pogue followed on SL-3 and SL-4. Next, I flew on Apollo-Soyuz, the American link-up with the Soviets in space.

In 1977, Fred Haise, Gordon Fullerton, Joe Engle, and Dick Truly (from groups 5 and 7) flew the Space Shuttle Approach and Landing Tests (ALT) in the Space Shuttle *Enterprise* at Edwards Air Force Base in California. The tests, directed by the program manager, Deke Slayton, were a resounding success.

Former astronaut Vance D. Brand in 2009.

Both Group 5 and Group 7 astronauts flew on the early Space Shuttle flights. Bob Crippen was pilot on the Shuttle's first mission (STS-1) into Earth orbit. The flight was high risk and a complete success. On STS-2, Engle became the only person to manually fly the Shuttle with the control stick for the complete entry, meaning that he had no assistance from the ship's autopilot. On STS-3, Lousma and Fullerton became the only ones to land the Shuttle (as it turned out in a raging dust storm) at Northrup Strip in New Mexico. On STS-4, Mattingly and Hank Hartsfield successfully completed the Shuttle Orbital Flight Test program which had consisted of 4 flights by two-man crews, after which NASA pinned the two ejection seats in *Columbia* to make them inoperative.

Bob Overmyer and I flew on STS-5, the first operational mission of the Shuttle, which included first-time deployment of (geosynchronous) satellites, continued Shuttle flight testing, and saw the first addition of mission specialists to the crew. On STS-6, Don Peterson was first to perform an EVA from the Shuttle (with Weitz as commander and Bobko as pilot). Truly was the first to land the Shuttle at night. McCandless was the first to perform an untethered EVA from the Shuttle. He was assisted by his Manned Maneuvering Unit (MMU) for propulsion, flew in formation with the Space Shuttle, *Challenger*, at orbital speed, and at a distance of more than 100 meters away (with me as commander). I was first to land the Space Shuttle at KSC. Crippen was commander of the first crew to repair a satellite in orbit. There were many other Shuttle firsts, some of which were accomplished on other early flights by astronauts Lousma, Fullerton, Mattingly, Hartsfield, Karol Bobko, and Don Lind.

With the exception of Ed Givens and John Bull from Group 5, all of the astronauts in the two groups eventually flew into space. Many flew multiple times. To summarize, nine from Group 5 flew to the Moon, and three of them walked on the Moon. Four from group 5 flew on Skylab, one flew on Apollo-Soyuz, and seven flew on Space Shuttle missions. The members of Group 7 missed out on Apollo, Skylab, and Apollo-Soyuz flights, but they all flew on early Space Shuttle missions.

Crippen and I had the most flights in our respective groups. We flew four times each, three times as commander. Flying my last spaceflight in 1990, I stayed in the astronaut corps longer than anyone else in either group. Their years with NASA provided great careers for members of astronaut groups 5 and 7.

After departing the astronaut corps, all of the former astronauts unsurprisingly headed in their own preferred directions. For example, after flying in space, several from groups 5 and 7 worked as consultants or managers in government or industry. Fullerton became a research pilot for the Dryden (now Armstrong) Flight Research Center, and Overmyer became a civilian test pilot for Cirrus Design.

Some in Group 5 achieved military flag officer rank and/or executive status after leaving the astronaut corps. Haise became a vice president of Grumman Aerospace Corporation and later president of Grumman Technical Services, Inc. Engle became a major general in the Air Force. Mattingly became a rear admiral in the Navy and later vice president of the X-33 program at Lockheed-Martin. Roosa became president of the Middle East Development Company, and later president and owner of Gulf Coast Coors, Inc. Swigert became executive director of the Committee on Science and Technology for the U.S. House of Representatives. In 1982, he was elected by Coloradoans to the U.S. House of Representatives but unfortunately died of cancer before being sworn into office. Weitz became deputy director of the Johnson Space Center.

Members of Group 7 also made an impressive showing after departure from the astronaut corps. Truly became a Navy vice admiral and commander of the Naval Space Command. After retiring from the Navy, he transferred to NASA, becoming Associate Administrator for Space Flight and finally the NASA Administrator under President George H.W. Bush. Following his retirement from NASA, Truly became director of the Department of Energy (DOE) National Renewable Energy Laboratory. Crippen became the center director at KSC, and after retirement from NASA, he became president of the Thiokol Propulsion Group. Hartsfield became an executive at Raytheon Company Intelligence, Information, and Services. Bobko became a principal at Booz Allen Hamilton and later the vice president for strategic programs at Spacehab. It is not shown here, but many of the above members of groups 5 and 7 also filled other lower level executive level positions in government and industry on their way up the ladder after departing the Astronaut Office.

Good timing, plus education, the right experience, and commendable individual capabilities boosted members of groups 5 and 7 to great achievement in the field of aerospace. Also, both groups were fortunate that their members were of the generation born in the 1930s. Previous generations had no opportunity to fly in space because space travel was not yet possible. The good news for the current and succeeding generations is that space will be a fast-moving frontier long into the future – with many opportunities and challenges yet to come.

Vance D. Brand
NASA Astronaut 1966-1992
Command Module Pilot Apollo ‘18’ (ASTP)
Commander STS-5, -41B and -35

Appendix A

D.J. Shayler, C. Burgess, *The Last of NASA's Original Pilot Astronauts*,
Springer Praxis Books, DOI 10.1007/978-3-319-51014-9

LIST OF CANDIDATES

Candidate Name	Birth date	Rank at time of selection	Age	Selection Group	Outcome of Application	Inactive Status	Died	Aged
Abrahamson, James A.	1933 May 19	Capt. USAF	34	USAF MOL III	SELECTED	1969 Jun		
Adams, Michael J.	1930 May 5	Capt. USAF	35	USAF MOL I	SELECTED	1966 Jul 20	1967 Nov 15	37
Armstrong, Spence M.	1934	Capt. USAF		USAF MOL II	Finalist	1966 Mar		
Atwell, Alfred L.	1929 Apr 18	Capt. USAF	35	USAF MOL I	Finalist	1964 Oct	2013 Apr 13	83
Bank, Milton H.	1935 Aug 11	Lt. USN	30	NASA Group 5	Finalist	1966 Mar	2010 May 25	74
Banks, Peter A,		Lt. Cmdr. USN		NASA Group 5	Finalist	1966 Mar		
Beale, Robert S.	1934 Jan 24	Capt. USAF	30	USAF MOL I	Finalist	1964 Oct		
Bell, Tommy I.	1930 Dec 4	Capt. USAF	33	USAF MOL I	Finalist	1964 Oct	2011 Feb 14	80
Blackburn, Harry L.	1935 Dec 28	Lt. USN	30	NASA Group 5	Finalist	1966 Mar	Unknown	
Bobko, Karol J.*	1937 Dec 23	Capt. USAF	28	USAF MOL II	SELECTED	1988 Nov 30		
Brand, Vance D.	1931 May 9	Civilian	34	NASA Group 5	SELECTED	1992 Mar		
Bull, John S.	1934 Sep 25	Lt. USN	31	NASA Group 5	SELECTED	1968 Jul	2008 Aug 11	73
Cabell, Jr., Charles P.	1936	Capt. USAF		USAF MOL III	Finalist	1967 May		
Carlton, John D.	1933 Jul 7	Capt. USMC	32	NASA Group 5	Finalist	1966 Mar	1992 Sep 15	59
Carr, Gerald P.	1932 Aug 22	Capt. USMC	33	NASA Group 5	SELECTED	1977 Jun 27		
Cherry, Jr., Richard E.	1932 Jul 28	Capt. USAF	33	NASA Group 5	Finalist	1966 Mar	2015 Feb 22	82
Crews, Jr., Albert H.	1929 Mar 23	Capt. USAF	36	USAF MOL I	SELECTED	1969 Jun		
Crippen, Robert L.*	1937 Sep 11	Lt. USN	28	USAF MOL II	SELECTED	1987 Jul		
Davey, Jr., Thomas J.		Capt. USAF		USAF MOL II	Finalist	1966 Mar		
Dettmer, John W.	1935 Sep 21	Capt. USAF	31	USAF MOL III	Finalist	1967 May		
Devereaux, Alan L.	1932 Dec 1	Capt. USAF	33	USAF MOL II	Finalist	1966 Mar		
Duke, Jr., Charles M.	1935 Oct 3	Capt. USAF	30	NASA Group 5	SELECTED	1975 Dec		
Engle, Joe H.	1932 Aug 26	Capt. USAF	33	NASA Group 5	SELECTED	1986 Nov 28		
Evans, Ronald E.	1933 Nov 10	Lt. USN	32	NASA Group 5	SELECTED	1977 Mar	1990 Apr 7	56
Finley, John L.	1935 Dec 22	Lt. USN	29	USAF MOL I	SELECTED	1968 Apr	2006 Sep 19	70
Foley, Brendan P.	1932 Mar 27	Capt. USAF	35	USAF MOL III	Finalist	1967 May	*1980 Oct 9*	
Frank, M. Peter	1930 Aug 20	Civilian	35	NASA Group 5	Finalist	1966 Mar	2005 Jun 22	74
Fullerton, Charles G.*	1936 Oct 11	Capt. USAF	29	USAF MOL II	SELECTED	1986 Oct	2013 Aug 21	76
Furlong, Jr., George	1931 Nov 23	Lt. Cmdr. USN	34	NASA Group 5	Finalist	1966 Mar		

(continued)

(continued)

Candidate Name	Birth date	Rank at time of selection	Age	Selection Group	Outcome of Application	Inactive Status	Died	Aged
Givens, Jr., Edward G.	1930 Jan 5	Maj. USAF	36	NASA Group 5	SELECTED	-	1967 Jun 6	37
Graff, John A.	1931	Maj. USAF		NASA Group 5	Finalist	1966 Mar	2014 Nov 8	
Greenamyer, Darryl	1936 Aug 13	Civilian	29	NASA Group 5	Finalist	1966 Mar		
Haise, Jr., Fred W.	1933 Nov 14	Civilian	32	NASA Group 5	SELECTED	1979 Jun		
Hartsfield, Jr., Henry W.*	1933 Nov 21	Capt. USAF	32	USAF MOL II	SELECTED	1988	2014 Jul 17	80
Hatchell, Ernest L.	1931 Jun 19	Maj. USAF	34	NASA Group 5	Finalist	1966 Mar		
Heinrich, George F.		Capt. USAF		NASA Group 5	Finalist	1966 Mar		
Henry, Jr., Patrick H.		Lt. USN		USAF MOL I	Finalist	1964 Oct		
Herres, Robert T.	1932 Dec 1	Maj. USAF	34	USAF MOL III	SELECTED	1969 Jun	2008 Jul 24	75
Holtzclaw, John W.	1934	Lt. USN		NASA Group 5	Finalist	1966 Mar		
Howard, Charles J.	1934 Dec 3	Civilian	31	NASA Group 5	Finalist	1966 Mar	2006 Oct 15	71
Hull, Wendell R.	1933 Apr 21	Capt. USAF	32	USAF MOL II	Finalist	1966 Mar	2015 Feb 18	81
Humphries, Jr., James F.	1934 Nov 13	Capt. USAF	31	USAF MOL II	Finalist	1966 Mar		
Irwin, James B.	1930 Mar 7	Maj. USAF	36	NASA Group 5	SELECTED	1972 Jul 1	1991 Aug 8	61
Jackson. Hugh M.		Civilian		NASA Group 5	Finalist	1966 Mar		
Kempton, Jimmy D.		Capt. USAF		USAF MOL III	Finalist	1967 May		
Kloves. Thomas R.	1933	Civilian		NASA Group 5	Finalist	1966 Mar		
Knight. William J.	1929 Nov 18	Capt. USAF	34	USAF MOL I	Finalist	1964 Oct	2004 May 7	74
Laidley, Richard A.	1929	Civilian		NASA Group 5	Finalist	1966 Mar	2015 Dec 21	86
Lawrence, Jr., Robert	1935 Oct 2	Capt. USAF	31	USAF MOL III	SELECTED	-	1967 Dec 8	32
Lawyer, Richard E.	1932 Nov 8	Capt. USAF	33	USAF MOL I	SELECTED	1969 Jun	2005 Nov 12	73
Lind, Don L.	1930 May 18	Civilian	35	NASA Group 5	SELECTED	1986 Mar		
Lousma, Jack R.	1936 Feb 29	Capt. USMC	30	NASA Group 5	SELECTED	1983 Oct 1		
Macleay, Lachlan	1931 Jun 13	Capt. USAF	34	USAF MOL I	SELECTED	1969 Jun		
Martin, Richard L.		Lt. USN		NASA Group 5	Finalist	1966 Mar		
Matter, Jr., Milton		Civilian		NASA Group 5	Finalist	1966 Mar		
Mattingly II, Thomas K.	1936 Mar 17	Lt. USN	30	NASA Group 5	SELECTED	1985 Jun		
McCandless II, Bruce	1937 Jun 8	Lt. USN	28	NASA Group 5	SELECTED	1990 Aug 31		
Merkl, Eldred D.	1936 Jan	Capt. USAF	31	USAF MOL III	Finalist	1967 May		
Metzko, John		Capt. USMC		NASA Group 5	Finalist	1966 Mar		
Mitchell, Edgar D	1930 Sep 17	Lt. Cmdr. USN	35	NASA Group 5	SELECTED	1972 Oct 1	2016 Feb 4	85

Morris, Gerald T.		Capt. USAF		USAF MOL III	Finalist	1967 May		
Neubeck, Francis G.	1932 Apr 11	Capt. USAF	33	USAF MOL I	SELECTED	1969 Jun		
O'Hara, Jack F.	1930 Apr 11	Cmdr. USN	35	NASA Group 5	Finalist	1966 Mar	1998 Feb 11	67
Olds, Ernest A.	1934 Jul 14	Capt. USAF	31	NASA Group 5	Finalist	1966 Mar	1968 Mar 11	33
Overmyer, Robert F.*	1936 Jul 14	Capt. USMC	29	USAF MOL II	SELECTED	1986 May	1996 Mar 22	59
Owings, Dwight C.	1932 Jan 20	Lt. USN	34	NASA Group 5	Finalist	1966 Mar	1966 Sep 27	34
Peterson, Donald H.*	1933 Oct 22	Capt. USAF	33	USAF MOL III	SELECTED	1984 Dec		
Pogue, William R.	1930 Jan 23	Maj. USAF	36	NASA Group 5	SELECTED	1975 Sep 1	2014 Mar 3	84
Pruitt, Leslie J.	1932 Aug 6	Capt. USAF	33	USAF MOL II	Finalist	1966 Mar		
Roosa, Stuart A.	1933 Aug 16	Capt. USAF	32	NASA Group 5	SELECTED	1976 Feb 1	1994 Dec 12	61
Rupp, Alexander K.	1930 Jul 2	Capt. USAF	34	USAF MOL I	Finalist	1964 Oct	1965 Jun 11	34
Sallada, Robert V.	1936	Lt. USN		NASA Group 5	Finalist	1966 Mar		
Shyken, Norman P.	1932 Nov 24	Civilian	33	NASA Group 5	Finalist	1966 Mar	1978 Jul 3	45
Smith, Gary T.	1931 May 10	Capt. USAF	35	USAF MOL III	Finalist	1967 May	1970 May 27	39
Stanley, James R.		Capt. USAF		USAF MOL II	Finalist	1966 Mar		
Swigert, Jr., John L.	1931 Aug 30	Civilian	34	NASA Group 5	SELECTED	1977 Aug 31	1982 Dec 27	51
Taylor, James M.	1930 Nov 27	Capt. USAF	33	USAF MOL I	SELECTED	1969 Jun	1970 Sep 4	39
Timm, Dwight D.	1933 Jul 30	Lt. USN	32	NASA Group 5	Finalist	1966 Mar	2016 Feb 26	82
Tonini, Gervasio	1935	Capt. USAF		USAF MOL I/II	Finalist	1966 Mar		
Truly, Richard, H.*	1937 Nov 12	Lt. USN	28	USAF MOL I	SELECTED	1983 Oct		
Waters, Joseph P.	1932 Mar 31	Capt. USAF	35	USAF MOL III	Finalist	1967 May	1972 Oct 16	40
Weitz, Paul J.	1932 Jul 25	Lt. Cmdr. USN	33	NASA Group 5	SELECTED	1994 May		
Worden, Alfred M.	1932 Feb 7	Capt. USAF	34	NASA Group 5	SELECTED	1972 Sep		

NOTES: [*] Denotes those MOL Astronauts who were subsequently transferred as members of NASA Group 7, August 1969.

Appendix B

D.J. Shayler, C. Burgess, *The Last of NASA's Original Pilot Astronauts*,
Springer Praxis Books, DOI 10.1007/978-3-319-51014-9

ASTRONAUT CAREERS AND SPACE FLIGHT EXPERIENCE

Name	Born	Selected	Group	Flights	First	Second	Third	Fourth	Hours	EVAs	Retired	Deceased	Notes
ABRAHAMSON. James A.	1933	1965	MOL III	0	-	-	-	-	-	-	1969		
ADAMS. Michael J.	1930	1965	MOL I	0	-	-	-	-	-	-	1966	1967	1
BOBKO. Karol J.	1936	1966/69	MOL II NASA 7	3	1983	1985	1985		386	0	1988		
BRAND. Vance D.	1931	1966	NASA 5	4	1975	1982	1984	1990	746	0	1992		
BULL. John S.	1934	1966	NASA 5	0	-	-	-	-	-	-	1968	2008	
CARR. Gerald P.	1932	1966	NASA 5	1	1973				2017	3	1977		
CREWS Jr. Albert H.	1929	1965	MOL I	0	-	-	-	-	-	-	1969		2
CRIPPEN. Robert L.	1937	1966/69	MOL II NASA 7	4	1981	1983	1984	1984	565	0	1995		
DUKE Jr. Charles M.	1935	1966	NASA 5	1	1972				265	4	1976		3
ENGLE. Joe H.	1932	1966	NASA 5	2	1981	1985			224	0	1986		4
EVANS Jr. Ronald E.	1933	1966	NASA 5	1	1972				301	1	1977	1990	
FINLEY. John L.	1935	1965	MOL I	0	-	-	-	-	-	-	1968	2006	
FULLERTON. C. Gordon	1936	1966/69	MOL II NASA 7	2	1982	1985			382	0	1986	2013	
GIVENS Jr. Edward G.	1930	1966	NASA 5	0	-	-	-	-	-	-	N/A	1967	5
HAISE Jr. Fred W.	1933	1966	NASA 5	1	1970				142		1979		
HARTSFIELD Jr. Henry W.	1933	1966/69	MOL II NASA 7	3	1982	1984	1985		482	0	1998	2014	
HERRES. Robert T.	1932	1967	MOL III	0	-	-	-	-	-	-	1969	2008	
IRWIN. James B.	1930	1966	NASA 5	1	1971				295	4	1972	1991	6
LAWRENCE. Robert H.	1935	1967	MOL III	0	-	-	-	-	-	-	N/A	1967	7
LAWYER. Richard E.	1932	1965	MOL I	0	-	-	-	-	-		1969	2005	
LIND. Don L.	1930	1966	NASA 5	1	1985				168	0	1986		
LOUSMA. Jack R.	1936	1966	NASA 5	2	1973	1982			1619	2	1983		
MACLEAY. Lachlan M.	1931	1965	MOL I	0	-	-	-	-	-	-	1969		
MATTINGLY II. T. Kenneth	1936	1966	NASA 5	3	1972	1982	1985		508	1	1985		
MCCANDLESS II. Bruce	1937	1966	NASA 5	2	1984	1990			312	2	1990		

(continued)

(continued)

Name	Born	Selected	Group	Flights	First	Second	Third	Fourth	Hours	EVAs	Retired	Deceased	Notes
MITCHELL. Edgar D.	1930	1966	NASA 5	1	1971				216	2	1972	2016	8
NEUBECK. Francis G.	1932	1965	MOL I	0	-	-	-	-	-	-	1969		
OVERMYER. Robert F.	1936	1966/69	MOL II NASA 7	2	1982	1985			290	0	1986	1996	
PETERSON. Donald H.	1933	1967/69	MOL III NASA 7	1	1983				120	1	1984		
POGUE William R.	1930	1966	NASA 5	1	1973				2017	2	1975	2014	
ROOSA. Stuart A.	1933	1966	NASA 5	1	1971				216	0	1976	1994	
SWIGERT Jr. John L.	1931	1966	NASA 5	1	1970				142	0	1977	1982	
TAYLOR. James M.	1930	1965	MOL I	0	-	-	-	-	-	-	1969	1970	
TRULY. Richard H.	1937	1965/69	MOL I NASA 7	2	1981	1983			199	0	1983		
WEITZ. Paul J.	1932	1966	NASA 5	2	1973	1983			793	2	1994		
WORDEN. Alfred M.	1932	1966	NASA 5	1	1971				295	1	1975		

KEY: M = MOL Selection/N = NASA Selection

NOTES:

1. Adams: Left the MOL group on July 20, 1966 to join the X-15 program. He was killed on November 15, 1967, on his seventh flight in the aircraft, during which he exceeded 50 miles in altitude and attained the USAF Astronaut Pilot Wings (posthumously).
2. Crews: Had been one of six pilots chosen in 1962 for the USAF X-20 space plane program, which was cancelled in 1963.
3. Duke: 10th man to walk on the Moon (1972, Apollo 16)
4. Engle: Served as an X-15 pilot between June 1963 and April 1966, flying 16 missions, of which three exceeded 50 miles in altitude and earned him the USAF Astronaut Pilot Wings. He was the first person to fly in orbit with previous experience of flying ‘in space above 50 miles’
5. Givens: Killed in an off-duty automobile accident, June 6, 1967
6. Irwin: 8th man to walk on the Moon (1971, Apollo 15)
7. Lawrence: Killed during training in the crash of an F-104 aircraft, Edwards AFB, California, December 8, 1967
8. Mitchell: 6th man to walk on the Moon (1971, Apollo 14)

Appendix C

SPACE FLIGHT RECORDS AND EVA EXPERIENCE

SPACE FLIGHT RECORDS (Alphabetical)							
Name	**NASA Group**	**Flights**	**Missions**	**Year**	**Mission Duration DD:HH:MM:SS**	**Career Total DD:HH:MM:SS**	**Notes**
Bobko	7/1969	3	STS-6	1983	5:00:23:42		1
			STS-51D	1985	6:23:55:23		
			STS-51J	1985	4:01:44:38	16:02:03:43	2
Brand	5/1966	4	ASTP	1975	9:01:28:24		3
			STS-5	1982	5:02:14:26		4
			STS-41B	1984	7:23:15:55		
			STS 35	1990	8:23:05:08	31:02:03:53	5
Carr	5/1966	1	Skylab 4	1973	84:01:15:37	84:01:15:37	6
Crippen	7/1969	4	STS-1	1981	2:06:20:53		7
			STS-7	1983	6:02:23:59		
			STS-41C	1984	6:23:40:07		
			STS-41G	1984	8:05:23:38	23:13:48:37	
Duke	5/1966	1	Apollo 16	1972	11:01:51:25	11:01:51:25	8
Engle	5/1966	2*	STS-2	1981	2:06:13:13		9
			STS-51I	1985	7:02:17:42	09:08:30:55	
Evans	5/1966	1	Apollo 17	1972	12:13:51:59	12:13:51:59	10
Fullerton	7/1969	2	STS-3	1982	8:00:04:45		
			STS-51F	1985	7:22:45:26	15:22:50:11	11
Haise	5/1966	1	Apollo 13	1970	5:22:54:41	5:22:54:41	12
Hartsfield	7/1969	3	STS-4	1982	7:01:09:31		13
			STS-41D	1984	6:00:56:04		14
			STS-61A	1985	7:00:44:53	20:02:50:28	
Irwin	5/1966	1	Apollo 15	1971	12:07:11:53	12:07:11:53	15
Lind	5/1966	1	STS-51B	1985	7:00:08:46	7:00:08:46	
Lousma	5/1966	2	Skylab 3	1973	59:11:09:04		16

(continued)

D.J. Shayler, C. Burgess, *The Last of NASA's Original Pilot Astronauts*,
Springer Praxis Books, DOI 10.1007/978-3-319-51014-9

(continued)

SPACE FLIGHT RECORDS (Alphabetical)

Name	**NASA Group**	**Flights**	**Missions**	**Year**	**Mission Duration DD:HH:MM:SS**	**Career Total DD:HH:MM:SS**	**Notes**
			STS-3	1982	8:00:04:45	67:11:13:49	
Mattingly	5/1966	3	Apollo 16	1972	11:01:51:25		8
			STS-4	1982	7:01:09:31		13
			STS-51C	1985	3:01:23:23	21:04:24:19	17
McCandless	5/1966	2	STS-41B	1984	7:23:15:55		
			STS-31	1990	5:01:16:06	13:00:32:01	18
Mitchell	5/1966	1	Apollo 14	1971	9:00:01:57	9:00:01:57	19
Overmyer	7/1969	2	STS-5	1982	5:02:14:26		4
			STS-51B	1985	7:00:08:46	12:02:23:12	
Peterson	7/1969	1	STS-6	1983	5:00:23:42	5:00:23:42	1
Pogue	5/1966	1	Skylab 4	1973	84:01:15:37	84:01:15:37	6
Roosa	5/1966	1	Apollo 14	1971	9:00:01:57	9:00:01:57	19
Swigert	5/1966	1	Apollo 13	1970	5:22:54:41	5:22:54:41	12
Truly	7/1969	2	STS-2	1981	2:06:13:13		9
			STS-8	1983	6:01:08:43	08:07:21:56	
Weitz	5/1966	2	Skylab 2	1973	28:00:49:49		20
			STS-6	1983	5:00:23:42	33:01:13:31	1
Worden	5/1966	1	Apollo 15	1971	12:07:11:53	12:07:11:53	15

NOTES:
(*) Spaceflight count for Engle *does not* include his three X-15 astro-flights (see below)
1. STS-6 was the maiden launch of OV-099 *Challenger*.
2. STS-51J was the maiden launch of OV-104 *Atlantis*.
3. ASTP was the first international docking mission between the USA and the USSR. The American mission, flown as Apollo 18 became the final mission of the first era of U.S. manned spaceflight (1961-1975).
4. STS-5 became the first ‘operational Shuttle mission.’
5. As Commander STS-35/Astro-1, Brand became the final member of the original NASA astronaut selections (1959-1969) to fly in space.
6. Skylab 4 set a world endurance record which was held by the Americans until March 1978, and a national endurance record held until July 1995.
7. STS-1 was the maiden launch of the Space Shuttle system, and of OV-102 *Columbia*. It was also the first of the Orbital Flight Test (OFT) program.
8. Apollo 16 was the fifth manned Apollo lunar landing mission.
9. STS-2 was the second OFT and first manned re-flight of a spacecraft.
10. Apollo 17 was the sixth and final Apollo lunar landing mission.
11. STS-51F was the only Abort-to-Orbit (ATO) situation in the Shuttle program.
12. Apollo 13 was the aborted third Apollo lunar landing attempt.
13. STS-4 was the fourth and final OFT.
14. STS-41D was the maiden launch of OV-103 *Discovery*.
15. Apollo 15 was the fourth Apollo manned lunar landing mission.
16. Skylab 3 set a new endurance record of 59 days until surpassed by Skylab 4.
17. STS-51C became the first classified Shuttle mission.
18. STS-31 deployed the Hubble Space Telescope (HST).
19. Apollo 14 was the third Apollo manned lunar landing mission.
20. Skylab 2 set a new endurance record of 28 days until surpassed by Skylab 3. The mission broke the Gemini 7 record of 14 days set in 1965.

ORDER OF MOST SPACE FLIGHT EXPERIENCE

Position	Total Duration DD:HH:MM:SS	Total Flights	Name	Group
=1	84:01:15:37	1	CARR. Gerald P.	5/1966
		1	POGUE. William R.	5/1966
3	67:11:13:49	2	LOUSMA. Jack R.	5/1966
4	33:01:13:31	2	WEITZ. Paul J.	5/1966
5	31:02:03:53	4	BRAND. Vance D.	5/1966
6	23:13:48:36	4	CRIPPEN. Robert L.	7/1969
7	21:04:24:19	3	MATTINGLY. Thomas K.	5/1966
8	20:02:50:28	3	HARTSFIELD. Henry W.	7/1969
9	16:03:03:45	3	BOBKO. Karol J.	7/1969
10	15:22:50:11	2	FULLERTON Charles G.	7/1969
11	13:00:32:01	2	MCCANDLESS. Bruce	5/1966
12	12:13:51:59	1	EVANS. Ronald E.	5/1966
13=	12:07:11:53	1	WORDEN. Alfred M.	5/1966
		1	IRWIN. James B.	5/1966
15	12:02:23:12	2	OVERMYER. Robert F.	7/1969
16	11:01:51:25	1	DUKE. Charles M.	5/1966
17	09:08:30:55	2*	ENGLE. Joe H.	5/1966
18=	09:00:01:57	1	ROOSA. Stuart A.	5/1966
		1	MITCHELL. Edgar D.	5/1966
20	08:07:21:56	2	TRULY. Richard H.	7/1969
21	07:00:08:46	1	LIND. Don L.	5/1966
22=	05:22:54:41	1	SWIGERT. John L.	5/1966
		1	HAISE. Fred W.	5/1966
24	05:00:23:42	1	PETERSON. Donald H.	7/1969

NOTE: [*] Engle also logged approximately 30 minutes (3 x 10 minutes) above 50 miles in three of his 16 X-15 flights prior to joining NASA which have not been included in these totals. If included his overall 'space flight' time would be: 5 missions: 9 days 9 hours and 55 seconds.

EXTRA VEHICULAR ACTIVITY EXPERIENCE (Order of most experience)

Name	NASA/ Group	Total EVAs	Mission	Date	Location	Duration Hr:min	Career EVA total	Notes
Duke	5/1966	4	Apollo 16	1972 Apr 21	LM/ Lunar surface	7:11		1
				1972 Apr 22	LM/ Lunar surface	7:23		
				1972 Apr 23	LM/ Lunar surface	5:40		
				1972 Apr 25	CM/Deep space	1:24	21:38	2
Irwin	5/1966	4	Apollo 15	1971 Jul 31	LM/ Lunar surface	6:14		3
				1971 Aug 1	LM/ Lunar surface	7:12		
				1971 Aug 2	LM/ Lunar surface	4:50		
				1971 Aug 5	CM/Deep space	0:39	18:55	2
Carr	5/1966	3	Skylab 4	1973 Dec 25	OWS/Earth orbit	7:01		
				1973 Dec 29	OWS/Earth orbit	3:38		
				1974 Feb 3	OWS/Earth orbit	5:19	15:58	
Pogue	5/1966	2	Skylab 4	1973 Nov 22	OWS/Earth orbit	6:33		
				1973 Dec 25	OWS/Earth orbit	7:01	13:34	
McCandless	5/1966	2	STS-41B	1984 Feb 7	OV-099/Earth orbit	5:55		4
				1984 Feb 9	OV-099/Earth orbit	6:17	12:12	
Lousma	5/1966	2	Skylab 3	1973 Aug 6	OWS/Earth orbit	6:31		
				1973 Aug 24	OWS/Earth orbit	4:30	11:01	
Mitchell	5/1966	2	Apollo 14	1971 Feb 5	LM/Lunar surface	4:48		5
				1971 Feb 6	LM/Lunar surface	4:35	9:23	
Peterson	7/1969	1	STS-6	1983 Apr 7	OV-099/Earth orbit	4:17	4:17	6
Weitz	5/1966	2	Skylab 2	1973 May 25	CM/Earth orbit	0:37		7
				1973 Jun 19	OWS/Earth orbit	1:44	2:21	
Mattingly	5/1966	1	Apollo 16	1972 Apr 25	CM/deep space	1:24	1:24	8
Evans	5/1966	1	Apollo 17	1972 Dec 17	CM/deep space	1:06	1:06	8
Worden	5/1966	1	Apollo 15	1971 Aug 5	CM/deep space	0:39	0:39	8

NOTES:
1. Duke became the 10th man to walk on the Moon.
2. This was a deep space stand-up EVA from the open CM hatch.

3. Irwin became the 8th man to walk on the Moon. On July 30 1971 he remained in LM cabin while Dave Scott performed a 27-minute stand-up EVA through overhead docking hatch of LM. As Irwin did not exit the LM that time is not recorded here.
4. McCandless became the first person to perform an untethered EVA in Earth orbit, wearing the Manned Maneuvering Unit
5. Mitchell became the 6th man to walk on the Moon.
6. Peterson accompanied Group 6 scientist astronaut Story Musgrave on the first EVA from a Space Shuttle; he was the only member of Group 7 to perform an EVA.
7. Weitz performed a stand-up EVA from the open CM side hatch in an attempt to deploy a stuck solar array on the unoccupied Skylab workshop.
8. Worden became the first person to conduct a deep space EVA. Mattingly completed a similar excursion on Apollo 16, as did Evans on Apollo 17.

Bibliography

This project concludes the authors' series of titles exploring the selection of NASA astronauts between April 1959 and August 1969. The research, both singularly and cooperatively, for this and the earlier works was conducted over many years, involving archival searching, first hand interviews, written and electronic correspondence, telephone conversations, official documentation and other contemporary sources.

A complete list of references and sources, from research of this magnitude, is beyond the scope of these few pages, but listed below are the primary interviews, major references and also suggested titles for further reading about the astronauts, their training, spaceflights in which they participated and about the program era in which they were active.

OTHER WORKS BY THE AUTHORS ON NASA ASTRONAUT GROUPS 1 – 7

Group 1, April 1959 (7 pilots)

2011 *Selecting the Mercury Seven: The Search for America's First Astronauts,* Colin Burgess, Springer-Praxis

Group 2, September 1962 (9 pilots) and Group 3 October 1963 (14 pilots)

1982 *NASA Astronaut Biographical Data Record Book, Group 3,* David J. Shayler, AIS Publications

2013 *Moon Bound: Choosing and Preparing NASA's Lunar Astronauts,* Colin Burgess, Springer- Praxis

Group 4, June 1965 (6 scientists) and Group 6, August 1967 (11 scientists)

1985 *NASA Astronaut Biographical Data Record Book, Group 4,* David J. Shayler, AIS Publications

1987 *NASA Astronaut Biographical Data Record Book, Group 6,* David J. Shayler, AIS Publications

2007 *NASA's Scientist-Astronauts,* David J. Shayler and Colin Burgess, Springer-Praxis

D.J. Shayler, C. Burgess, *The Last of NASA's Original Pilot Astronauts*,
Springer Praxis Books, DOI 10.1007/978-3-319-51014-9

Group 5, April 1966 (19 pilots) and Group 7, August 1969 (7 former MOL transfers)

1983 *NASA Astronaut Biographical Data Record Book, Group 5,* David J. Shayler, AIS Publications

1983 *NASA Astronaut Biographical Data Record Book, Group 7,* David J. Shayler, AIS Publications

PERSONAL INTERVIEWS

Vance Brand	Aug 1989 (Shayler), Jun 2013 (Burgess)
Jerry Carr	Aug 1988, Aug 1989, Sep 1994, Dec 1997, Dec 1998, Jul 2000, Oct 2002, Sep 2003, Nov 2004
Bill Pogue	Sep 1999, Jul 2000
Jack Lousma	Mar 2001, Jun 2004 (Shayler), Jun 2013 (Burgess)
Don Lind	May 2000
Bruce McCandless	Aug 1989, Aug 2006
Robert Crippen	Jun 2004, Feb 2013

UNRECORDED DISCUSSIONS

Vance Brand, Jerry Carr, Charles Duke, Don Lind, Jack Lousma, Ed Mitchell, Paul Weitz, and Al Worden,

WRITTEN CORRESPONDENCE

Vance Brand, Jerry Carr, Jim Irwin, Jack Lousma, Bill Pogue, Fred Haise, Frank Ellis

NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT

Abrahamson	Jul 23, 2012
Bobko	Feb 12, 2002
Brand	Jul 25, 2000, Apr 12, 2002
Carr	Oct 25, 2000
Crews	Aug 6, 2007
Crippen	May 26, 2006
Duke	Mar 12, 1999
Engle	Apr 22, 2004, May 5, 2004, May 27, 2004, Jun 3, 2004, Jun 24, 2004
Evans (Jan)	Aug 7, 2003
Fullerton	May 6, 2002
Haise	Mar 23, 1999
Hartsfield	Jun 12, 2001, Jun 15, 2001
Lind	May 27, 2005

Lousma	Mar 7, 2001, Mar 15, 2010
Mattingly	Nov 6, 2001, Apr 22, 2002
Mitchell	Sep 3, 1997
Peterson	Nov 14, 2002
Pogue	Jul 17, 2000
Truly	Jun 2005
Weitz	Mar 26, 2000, Nov 8, 2000
Worden	May 26, 2000

BIOGRAPHICAL RECORDS

Both authors have their own personal collection of material for each of the astronauts featured in this work. These files have supplemented official documentation, media reports, flight documentation and reports on each astronaut from the 1966 and 1969 selections. This in-depth research has been supplemented by personal correspondence, email, and telephone calls for well over four decades.

PERIODICALS

Aviation Week and Space Technology
MSC/JSC Roundup
NASA Activities
Orbiter (Astro Info Service Ltd)
Spaceflight (British Interplanetary Society)
Spaceflight News
Quest
World Spaceflight News

NEWSPAPERS

Florida Today
Houston Chronicle
Houston Post
The Daily Telegraph
The Times, London
Washington Post

NASA PUBLICATIONS

1965-1992	*Astronautics and Aeronautics, A Chronology,* NASA SP various editions
1975	*Apollo Program Summary Report,* NASA Johnson Space Center, JSC-09423

1978 *The Partnership, A History of the Apollo-Soyuz Test Project*, Edward C. Ezell and Linda N. Ezell, NASA SP-4209

1983 *Living and Working in Space: A History of Skylab*, W. David Compton and Charles D. Benson, NASA SP-4208

1989 *Where No Man Has Gone Before, a History of Apollo Lunar Exploration Missions*, W. David Compton, NASA SP-4214

1997 *Walking to Olympus: An EVA Chronology,* David S.F. Portree and Robert C. Treviño, NASA Monograph in Aerospace History, #7

2015 *Science Training History of the Apollo Astronauts*, William C. Phinney, NASA SP-2015-626

BOOKS *AUTHORED BY* NASA GROUP 5 ASTRONAUTS

Vance Brand

2015 *Flying Higher and Faster,* Mira Digital

Charles Duke

1990 *Moonwalker* (with Dottie Duke), Oliver Nelson

James Irwin

1973 *To Rule the Night, The Discovery Voyage of Astronaut Jim Irwin* (with William A. Emerson Jr.), Holman

1983 *More Than Earthlings,* Baptist Sunday School Board (religious)

1989 *Destination Moon,* Multnomah Books (juvenile literature)

Ed Mitchell

1974 *Psychic Exploration, A Challenge for Science,* G. Putnam and Sons

1996 *The Way of the Explorer, An Apollo Astronaut's Journey Through the Material and Mystical Worlds* (with Dwight Williams), Putnam

2014 *Earthrise, My Adventures as an Apollo 14 Astronaut* (with Ellen Mohoney), Chicago Review Press, (juvenile literature)

William Pogue

1991 *How Do You Go to the Bathroom in Space?* Tor Books (revised edition)

1993 *The Trikon Deception* (with Ben Bova), Tor books, (techno-thriller)

2003 *Space Trivia,* Apogee Books

2011 *But for the Grace of God, an Autobiography of an Aviator and Astronaut,* Soar with Eagles

Al Worden

1974 *Hello Earth, Greetings from Endeavour,* Nash Publishing (poetry)

2011 *Falling to Earth, An Apollo 15 Astronaut's Journey to the Moon* (with Francis French), Smithsonian

BOOKS *ABOUT* NASA GROUP 5 ASTRONAUTS

Jerry Carr

2008 *Around the World in 84 Days, the Authorized Biography of Skylab Astronaut Jerry Carr,* David J. Shayler, *Apogee Books*

Don Lind

1985 *Don Lind, Mormon Astronaut,* Kathleen Maughan Lind, Deseret Books

Stu Roosa

2011 *Smoke Jumper, Moon Pilot, the Remarkable Life of Apollo 14 Astronaut Stuart Roosa,* Willie G. Moseley, Acclaim Press

Also

Ed Givens

2003 *A Lonely Stretch of Road,* by Colin Burgess in *Fallen Astronauts, Heroes who Died Reaching for the Moon,* University of Nebraska Press

OTHER BOOKS

1973 *13: The Flight that Failed,* Henry S.F. Cooper, Jr., Angus and Robertson

1977 *A House in Space,* Henry S.F. Cooper Jr., Angus Robertson

1981 *The History of Manned Spaceflight*, David Baker, PhD, New Cavendish Books

1985 *The Real Stuff, A History of NASA's Astronaut Recruitment Program,* Joseph D. Atkinson, Jr. & Jay M. Shafritz, Praeger Publishers

1987 *Shuttle Challenger, Aviation Fact File*, David J. Shayler, Salamander Books

Before Lift-Off: The Making of a Space Shuttle Crew, Henry S.F. Cooper, Jr., John opkins University Press

1989 *Moon Trip, A Personal Account of the Apollo Program and its Science,* Bert King, University of Houston

1992 *The Shuttlenauts 1981-1992: The First 50 Missions, Volume 1 Mission Data,* David J. Shayler, AIS Publications.

The Shuttlenauts 1981-1992: The First 50 Missions, Volume 2 Shuttle Flight Crew Assignments, David J. Shayler, AIS Publications.

1992 *Men and Women of Space,* Douglas B. Hawthorne, Univelt

1993 *To a Rocky Moon, A Geologist's History of Lunar Exploration,* Don E. Wilhelms, The University of Arizona Press

1994 *Deke! U.S. Manned Space: From Mercury to the Shuttle,* Donald K. 'Deke' Slayton with Michael Cassutt

Lost Moon, The Perilous Voyage of Apollo 13, Jim Lovell and Jeffrey Kluger, Houghton Mifflin

1996 *The Shuttlenauts 1981-1992: The First 50 Missions, Volume 3 Flight Crew Biography Profiles,* David J. Shayler, AIS Publications.

1999 *Who's Who in Space, the International Space Station Edition,* Michael Cassutt, Macmillan

2000 *Disasters and Accidents in Manned Spaceflight,* David J. Shayler, Springer-Praxis
2001 *Skylab, America's Space Station,* David J. Shayler, Springer-Praxis
Taking Science to the Moon, Lunar Experiments and the Apollo Program, Donald A. Beattie, John Hopkins University Press
2002 *Apollo, The Lost and Forgotten Missions*, David J. Shayler, Springer-Praxis
2004 *The Story of the Space Shuttle*, David M. Harland, Springer-Praxis
Walking in Space, David J. Shayler, Springer-Praxis
2005 *Space Shuttle Columbia, Her Missions and Crews,* Ben Evans, Springer-Praxis
2006 *Apollo, the Definitive Sourcebook*, Richard W. Orloff and David M. Harland, Springer-Praxis
2007 *Praxis Manned Spaceflight Log, 1961-2006,* Tim Furniss, David J. Shayler with Michael D. Shayler, Springer-Praxis
Space Shuttle Challenger, Ten Journeys into the Unknown, Ben Evans, Springer-Praxis
On the Moon, The Apollo Journals, Grant Heiken and Eric Jones, Springer-Praxis
2008 *Exploring the Moon, The Apollo Expeditions, 40th Anniversary Edition,* David M. Harland, Springer-Praxis
2012 *Inventing the American Astronaut,* Matthew H. Hersch, Palgrave Macmillan
2016 *The Hubble Space Telescope, From Concept to Success,* David J. Shayler with David M. Harland, Springer-Praxis
Into the Black: The Extraordinary Untold Story of the First Flight of the Space Shuttle and the Men Who Flew Her, Rowland White, Bantam Press
North American X-15, 1954-1968, Owner's Workshop Manual, David Baker, Haynes Publishing

Springer-Praxis *A History of Human Space Exploration* –by Ben Evans

2009 *Escaping the Bonds of Earth*, The Fifties and the Sixties
2010 *Foothold in the Heavens*, The Seventies
2012 *At Home in Space*, The late Seventies into the Eighties
Tragedy and Triumph in Orbit, The Eighties and Early Nineties

University of Nebraska Press *Outward Odyssey, A People's History of Spaceflight* – Series Editor Colin Burgess

2007 *In the Shadow of the Moon, A Challenging Journey to Tranquility, 1965-1969,* Francis French and Colin Burgess
2008 *Homesteading Space, The Skylab Story,* David Hitt, Owen Garriott, and Joe Kerwin
2010 *Footprints in the Dust, The Epic Voyages of Apollo, 1969-1975,* Ed. Colin Burgess
2013 *The X-15 Rocket Plane, Flying the First Wings into Space*, Michelle Evans
Wheels Stop, The Tragedies and Triumphs of the Space Shuttle Program, 1986-2011, Rick Houston
2014 *Bold they Rise, The Space Shuttle Early Years, 1972-1986,* David Hitt and Heather R. Smith

About the authors

DAVID J. SHAYLER

Spaceflight historian David J. Shayler, F.B.I.S. (Fellow of the British Interplanetary Society or – as Dave likes to call it – Future Briton In Space!), was born in England in 1955. After leaving school, Dave began training as an engineering draughtsman prior to serving in HM Forces Royal Marines. Following his return to civilian life, he worked in a variety of roles within the retail industry for almost 30 years before becoming a full-time writer.

His lifelong interest in space exploration began by drawing rockets aged 5, but it was not until the launch of Apollo 8 to the Moon in December 1968 that his interest in human space exploration became a passion. He fondly recalls staying up all night with his grandfather to watch the Apollo 11 Moonwalk. Dave joined the British Interplanetary Society (BIS) as a Member in January 1976, becoming an Associate Fellow in 1983, and Fellow in 1984. He was elected to the Council of the BIS in 2013. The BIS published his first articles in the late 1970s, and in 1982 he created Astro Info Service (www.astroinfoservice.co.uk) to focus his research efforts.

Dave's first book was published in 1987 and has been followed by over 20 other titles, featuring works on the American and Russian space programs, spacewalking, women in space, and the human exploration of Mars. Dave's authorized biography of Skylab 4 astronaut Jerry Carr was published in 2008.

In 1989, Dave applied as a cosmonaut candidate for the U.K. Project Juno cooperative program with the Soviet Union (now Russia). The mission was to spend seven days in space aboard the space station Mir. Dave did not reach the final selection but progressed further than he expected. The mission was flown by Helen Sharman in May 1991. In support of his research, Dave has visited NASA field centers in Houston and Florida in the United States and the Yuri Gagarin Cosmonaut Training Center in Russia. During these trips, Dave was able to conduct in-depth research, interview many space explorers and workers, tour training facilities, and handle real space hardware. He also gained valuable

D.J. Shayler, C. Burgess, *The Last of NASA's Original Pilot Astronauts*,
Springer Praxis Books, DOI 10.1007/978-3-319-51014-9

insights into the activities of a space explorer and the realities of not only flying and living in space, but also what goes into preparing for a mission and planning future programs.

Dave is a friend of many former and current astronauts and cosmonauts, some of whom have accompanied Dave on visits to schools across the country. For over 30 years, Dave has delivered space-themed presentations and workshops to children and social groups across the U.K. This program is intended to help the younger generation develop an interest in science and technology and the world around them, in addition to informing the general public and interested individuals about the history and development of human space exploration.

Dave lives in the West Midlands region of the U.K. and enjoys spending time with his wife Bel and their rather large, young, white German Shepherd called Shado, and indulging in his love of cooking, fine wines and classical music. His other interests are in reading about military history (especially the Napoleonic Wars), visiting historical sites and landmarks, and following Formula 1 motor racing.

COLIN BURGESS

Australian author Colin Burgess grew up in Sydney's southern suburbs, where he and his wife Patricia still live. They have two grown sons, two grandsons and a granddaughter.

His working life began in the wages department of a major Sydney afternoon newspaper, where he first picked up his writing bug, and later as a sales representative for a precious metals company. He subsequently joined Qantas Airways as a passenger handling agent in 1970 and two years later, he transferred to the airline's cabin crew. He retired from Qantas as an onboard Flight Service Director/Customer Service Manager in 2002, after 32 years' service.

During that period, several of his books on the Australian prisoner-of-war experience were published, as well as the first of his biographical books on space explorers such as Australian payload specialist Dr. Paul Scully-Power and *Challenger* teacher Christa McAuliffe. He has also written extensively on spaceflight subjects for astronomy and space-related magazines in Australia, the United Kingdom and the United States.

In 2003, the University of Nebraska Press appointed him Series Editor for their ongoing *Outward Odyssey* series of books detailing the entire social history of space exploration, and he was involved in co-writing three of these volumes. His first Springer-Praxis book, *NASA's Scientist-Astronauts*, also co-authored with British-based space historian David J. Shayler, was released in 2007. *NASA's Pilot Astronaut Groups of the Late 1960s* will be his 13th title in a decade's association with Springer-Praxis, for whom he is currently researching further books for future publication. He regularly attends astronaut functions in the United States and is well known to many of the pioneering space explorers, allowing him to conduct personal interviews for his publications.

Other works by the authors

By David J. Shayler and Colin Burgess in this series

NASA's Scientist-Astronauts (2006), ISBN 0-387-21897-1

Other space exploration books by David J. Shayler

Challenger Fact File (1987), ISBN 0-86101-272-0
Apollo 11 Moon Landing (1989), ISBN 0-7110-1844-8
Exploring Space (1994), ISBN 0-600-58199-3
All About Space (1999), ISBN 0-7497-4005-X
Around the World in 84 Days: The Authorized Biography of Skylab Astronaut Jerry Carr (2008), ISBN 9781-894959-40-7

With Harry Siepmann

NASA Space Shuttle (1987), ISBN 0-7110-1681-X

Other books by David J. Shayler in this series

Disasters and Accidents in Manned Spaceflight (2000), ISBN 1-85233-225-5
Skylab: America's Space Station (2001), ISBN 1-85233-407-X
Gemini: Steps to the Moon (2001), ISBN 1-85233-405-3
Apollo: The Lost and Forgotten Missions (2002), ISBN 1-85233-575-0
Walking in Space (2004), ISBN 1-85233-710-9
Space Rescue (2007), ISBN 978-0-387-69905-9

With Rex Hall M.B.E.

The Rocket Men (2001), ISBN 1-85233-391-X
Soyuz: A Universal Spacecraft (2003), ISBN 1-85233-657-9

With Rex Hall M.B.E. and Bert Vis

Russia's Cosmonauts (2005), ISBN 0-38721-894-7

D.J. Shayler, C. Burgess, *The Last of NASA's Original Pilot Astronauts*,
Springer Praxis Books, DOI 10.1007/978-3-319-51014-9

With David M. Harland

Hubble Space Telescope: From Concept to Success (2016) ISBN 978-1-4939-2826-2
Enhancing Hubble's Vision: Service Missions That Expanded Our View of the Universe (2016) ISBN 978-3-319-22643-9

With Ian Moule

Women in Space: Following Valentina (2005), ISBN 1-85233-744-3

Other books by David J. Shayler and Michael D. Shayler in this series

Manned Spaceflight Log II – 2006-2012 (2013), ISBN 978-1-4614-4576-0

With Andrew Salmon

Marswalk One: First Steps on a New Planet (2005), ISBN 1-85233-792-3

With Tim Furniss

Praxis Manned Spaceflight Log: 1961–2006 (2007), ISBN 0-387-34175-7

Other space exploration books by Colin Burgess

Space, the New Frontier, (1987) ISBN 978-0868963617
Oceans to Orbit: The Story of Australia's First Man in Space, Paul Scully-Power, (1995) ISBN 978-0949853530
Australia's Astronauts: Three Men and a Spaceflight Dream, (1999) ISBN 978-0731808311
Teacher in Space: Christa McAuliffe and the Challenger Legacy, (2000) ISBN 978-0803261822
Australia's Astronauts: Countdown to a Spaceflight Dream, (2009) ISBN 978-0975228616
Footprints in the Dust: The Epic Voyages of Apollo, 1969–1975, (2010), Ed. By Colin Burgess ISBN 978-803226654

With Kate Doolan

Fallen Astronauts: Heroes Who Died Reaching for the Moon, (2003) 978-0803262126

With Francis French

Into That Silent Sea: Trailblazers of the Space Era, 1961–1965, (2007) ISBN 978-0803211469
In the Shadow of the Moon: A Challenging Journey to Tranquility, 1965–1969, (2007) ISBN 978-0803211285978

Other books by Colin Burgess in this series

Selecting the Mercury Seven: The Search for America's First Astronauts (2011) ISBN 978-1-4419-8404-3
Moon Bound: Choosing and Preparing NASA's Lunar Astronauts (2013) ISBN 978-1-4614-3854-0

Freedom 7: The Historic Flight of Alan B. Shepard, Jr. (2014) ISBN 978-3-3190-1155-4
Liberty Bell 7: The Suborbital Mercury Flight of Virgil I. Grissom (2014) ISBN 978-3-319-04390-6
Friendship 7: The Epic Orbital Flight of John H. Glenn, Jr. (2015) ISBN 978-3-319-15653-8
Aurora 7: The Mercury Spaceflight of M. Scott Carpenter (2015) ISBN 978-3-319-20438-3
Sigma 7: The Six Mercury Orbits of Walter M. Schirra, Jr. (2016) ISBN 978-3-319-27982-4
Faith 7: L. Gordon Cooper, Jr. The Final Mercury Mission. (2016) ISBN 978-3319-30562-2

With Chris Dubbs

Animals in Space: From Research Rockets to the Space Shuttle (2007) ISBN 978-0-387-36053-9

With Rex Hall, M.B.E.

The First Cosmonaut Team: Their Lives, Legacies and Historical Impact (2009) ISBN 978-0-387-84823-5

With Bert Vis

Interkosmos: The Eastern Bloc's Early Space Program (2016) ISBN 978-3-319-24161-6

Index

D.J. Shayler, C. Burgess, *The Last of NASA's Original Pilot Astronauts*, Springer Praxis Books, DOI 10.1007/978-3-319-51014-9