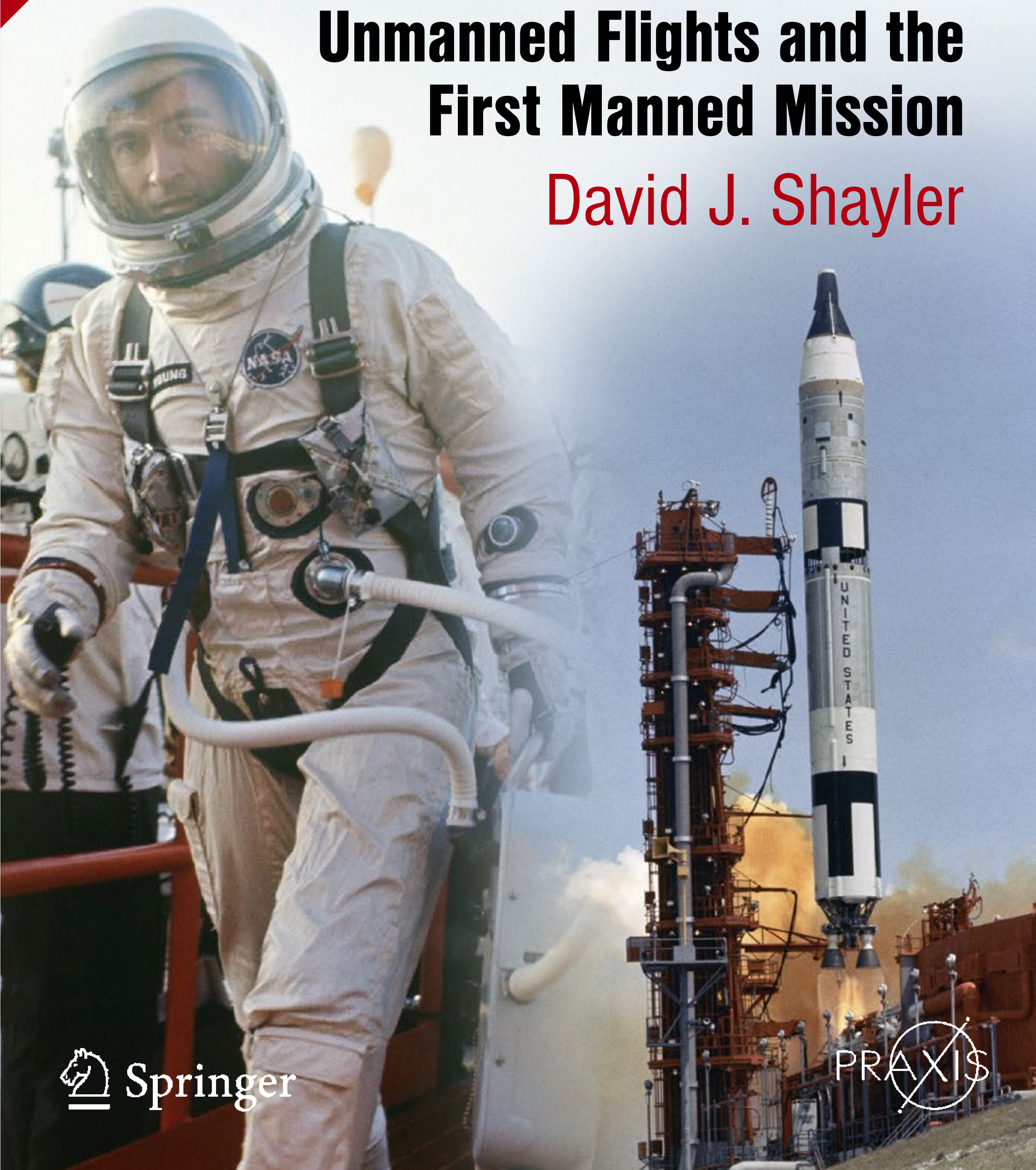
PIONEERS IN EARLY SPACEFLIGHT

Gemini Flies!

Unmanned Flights and the First Manned Mission

David J. Shayler



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Front cover: The operational era of Project Gemini began on April 8, 1964 with the launch of the unmanned Gemini 1 from Pad 19, Cape Kennedy, Florida, atop the two-stage Titan II launch vehicle (right). This was followed less than one year later by the first manned flight, Gemini 3, nicknamed '*Molly Brown*' by Command Pilot Virgil I 'Gus' Grissom and Pilot John W. Young. Young is seen here striding towards the elevator at the launch pad to take up his place in the spacecraft on March 23, 1965 (left). (Courtesy Ed Hengeveld).

Back cover: (Right) Between Gemini 1 and Gemini 3, the unmanned Gemini 2 flew a sub-orbital test of the spacecraft's heat shield in January 1965, clearing the way for manned operations. Here, the spacecraft's re-entry module is seen on the recovery carrier after being retrieved from the ocean (Courtesy Ed Hengeveld).

(Left) The cover for the next book in this series covering the four-day mission of Gemini 4 in June 1965, which included America's first experience of extravehicular activity (more commonly known as a spacewalk).

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Author's Preface

Unfortunately, I missed the whole of the Gemini program as it was happening. In 1965, as a ten-year-old in primary school and a veteran of such children's TV space programs as *Fireball XL-5*, *Space Patrol* and the 'original' *Doctor Who*, I was too young to appreciate the news bulletins and newspaper headlines of the real space program. The earliest memory I have of an actual event to do with space is the Monday morning school assembly of January 30, 1967, during which a prayer was said for the Apollo 1 astronauts who had died the previous Friday. My next memory, this time from a spaceflight, was of the black and white TV transmissions from Apollo 7 in October 1968. Then, from the launch of Apollo 8 on December 21, 1968 onwards, I was hooked and never looked back. Since then, there has not been a day that I have not thought about the space program. By 1968, I was in secondary school – now a 13-year-old – and we were given a school project to complete for the end of term. For me the choice was easy – I chose Apollo.

While researching the subject, one of the books I found in the school library was Kenneth Gatland's *The Manned Spacecraft Pocket Encyclopedia of Space Flight in Colour* (Blandford, 1967). Within its pages, I eagerly read about the Gemini missions for the first time. Then, during the Apollo 8 mission, I learned more about the first spaceflights of Frank Borman and Jim Lovell on Gemini 7 just before Christmas 1965 and about Lovell's return to space almost a year later with Edwin E. 'Buzz' Aldrin (as he was known then) on Gemini 12, which ended the short program. Gemini fascinated me, both in what it had achieved in such a short timescale from concept to completion and in what was promised, but never delivered, by the military and civilian space programs.

A few years later, as a keen model maker, I was the proud owner of Revell's 1/48th scale Mercury and Gemini spacecraft, a larger 1/24th scale Gemini model and a 1/12th scale representation of 'a Gemini astronaut' performing EVA. There was even a board game based upon Gemini and I still have it in my collection. The Waddington Company had produced a game called '*Blast-off,*' part of which involved rendezvous and docking in orbit using little plastic models of the Gemini and Agena spacecraft. It was a game with which I had hours of fun. So, even though I had missed the 'real' Gemini missions, I had become fascinated by this series of ten manned missions which were deemed essential to

Apollo's chances of successfully reaching the Moon. Over the past 50 years that interest has never really gone away, it just became diverted a little.

Since the late 1960s, I have amassed a fair collection of books, reports, cuttings and images, but have remained surprised by the relative lack of information on Gemini over the years. I had acquired Gus Grissom's *Gemini*, the official NASA history *On the Shoulders of Titans* and the official chronology of the program, as well as the more personal accounts by Mike Collins (*Carrying the Fire*) and Buzz Aldrin (*Return to Earth*). Each year, I eagerly awaited the next piece to the jigsaw, hoping for more dedicated books on each mission, but throughout the 1970s and into the 1990s those titles never appeared. It was not until 1988 and my first visit to NASA Johnson Space Center's History Office and the archives at Rice University, Houston, that I discovered the wealth of information just waiting to be researched. At that time, I was researching the topics of space suits and EVA operations and had the good fortune to interview Gene Cernan about his experiences on Gemini 9. Searching the 'retired' Gemini archives at Rice (which were subsequently moved to NARA in Fort Worth in 2000) simply amazed me and I eagerly delved deeper, vowing to "write a book on the subject" one day. That had to wait until 2000 when I finally secured a contract, from Springer-Praxis, to produce a summary of the Gemini program, which was published the following year as *Gemini: Steps to the Moon*. Although this was great fun to write, I always felt that I could have done more with the accounts of each mission, but there was simply not enough room in one volume to do this justice. For the next fifteen years the idea was shelved as other projects took over.

Then, in 2014, my good friend and colleague Colin Burgess embarked upon a series of books featuring the six manned missions of Project Mercury. Towards the end of that series, Colin told me that he was not contemplating continuing the series beyond Mercury and, eager to see the series continue into the next stage, I decided to take up the mantle and attempt to write about each Gemini mission in more detail than in my earlier book. Even with the long-duration Gemini 7 mission combined with short duration Gemini 6 rendezvous mission, this would still mean nine titles, or more than a third of my total output from the previous 25 years! As daunting as this might seem, Springer was fortunately keen on the idea and would support the venture, with the books appearing under their *Pioneers in Early Spaceflight* series. The gauntlet was cast, but it was an exciting idea and a quest I was eager to embark upon.

I had decided early on to incorporate the unmanned missions of Gemini 1 and 2 into this first title in the series detailing the three-orbit test flight of Gemini 3 (or '*Molly Brown*'). Each title would complement, yet not replace, the information originally published in *Gemini: Steps to the Moon*. These new works will rely heavily on the air-to-ground commentary recorded during each mission, as well as official pre- and post-flight reports, various newspaper accounts of the day, contemporary sources and, wherever possible, extracts from interviews or information provided by those who participated in the program. I had also decided to expand on information unique to the mission being flown, so in this book on Gemini 3, details of the spacecraft's maneuvering system and heat shield are explained. The fledgling story of EVA will be introduced in the Gemini 4 title, while the challenge of long-duration flight will be covered in the Gemini 5 and 7 titles. Next comes mastering the techniques of rendezvous and docking, which will feature in the

Gemini 6 account and Gemini 8 title. Overcoming other difficulties to develop 'routine' operations in Earth orbit will be discussed in the final titles covering Gemini 9 through 12.

Gemini was a pivotal program, not just for Apollo or American spaceflight in general, but in the early history of human spaceflight. So much was learned during those few short months of 1965 and 1966, much of which was directly relevant to so many programs that followed long after Apollo ended and continues to be so for those yet to fly. The story needs to be told, step by step, mission by mission, of a program that followed in the wake of the pioneering missions of Mercury and created the confidence to embark upon Apollo and beyond.

As the title suggests, this volume explains how *Gemini Flies* during the two unmanned missions which preceded the historic flight of Gus Grissom and John Young in *Molly Brown*, the first manned mission that completed the testing phase of Gemini so successfully. The official testing may have ended with Gemini 3, but this was only the very start of the story and a remarkable journey. I may have missed Gemini real-time, but I am sure that writing this series will address that lament.

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August, 2017

Acknowledgements

In the acknowledgments of my earlier book on Gemini, I gratefully thanked the network of colleagues, space sleuths, historians and archivists who formed part of a global infrastructure of contacts, long before the existence of the world-wide-web. This global network of contacts fortunately continues to this day.

For this project in particular, I appreciate the continued support and assistance of Colin Burgess, for his fitting Foreword to the first book in this series and for his support in embarking on this journey through Gemini. Thanks also to David Harland, editor extraordinaire and author of the excellent *How NASA Learned to Fly in Space* (Apogee 2004), for his guidance towards a number of rare Gemini documents and archives, as well as to Michael Cassutt for further clarification of the intricacies of the NASA Astronaut Office of the mid-1960s. A special thanks to Ed Hengeveld and to Joachim Becker of *SpaceFacts.de* for providing the elusive Gemini images and for their unselfish support in enhancing the presentation of these volumes with those images.

The majority of images used in this book originate from NASA, various military service organizations, the author's own collection and those credited in the individual captions, unless specifically stated. However, despite extensive searches, I have been unable to determine the exact origins of some of the images. I would welcome any input to enable me to credit the appropriate source.

Over a period of fourteen years – 1988 through 2002 – I was fortunate to be able to visit and work within the History Offices of NASA JSC, the archives at NARA Fort Worth and the Universities in Houston at Clear Lake and Rice. I therefore once again express my heartfelt gratitude to the staff of the NASA History Office at JSC, including, successively, Janet Kovacevich, Joey Pellerin and Asha Vasha, David Portree, Glen Swanson and more recently, John Uri. The History Office staff at Washington D.C., notably in the 1980s Lee Saegesser, latterly Steve Dick, Roger Launius and currently Bill Barry. Thanks to Shelly Kelly at the JSC History Archive, Clear Lake University and to Joan Ferry and staff at the Fondren Library, Rice University, where the Gemini collection was held up to the late 1990s until it was moved to NARA, Fort Worth, where Meg Hacker and Michael Wright continued to assist.

To the staff of the now discontinued Still Photo Archive at JSC (Mike Gentry, Lisa Vasquez, Debbie Dodds, Mary Wilkinson and Jody Russell) who were always helpful in answering imagery queries, as were Margaret Persinger at KSC and Gwen Pitman at NASA in Washington. Another much-missed research archive is the former JSC Audio Library and here thanks go to former employees Diana Ormsbee and Pete Nubile. At KSC, help has also been forthcoming from Archivist Kay Grinter, the Center Historian Ken Nail and Elaine Liston.

I am especially indebted to former Gemini Flight Controller Erik 'Dutch' von Ehrenfried for explaining some of the intricacies of Mission Control of the mid 1960s, as well as providing some elusive documents, rare images and words of encouragement.

As always, I must thank the support and encouragement of the staff and Council of the British Interplanetary Society in London, especially the former Executive Secretary Suszann Parry and her successor Gill Norman. Thanks also to the Library and History Committees for access to the books, reports and releases held in the wonderful resource of the Society's Library.

No Springer-Praxis title could exist without a word of thanks and appreciation for the support, insight and encouragement of Clive Horwood of Praxis Publishers. Appreciation also goes to his team of Proposal Reviewers and to Jim Wilkie for his excellent artistry in converting my original cover ideas to the masterpiece you see here. Jim's skills in every cover he creates makes each book a leading attraction on the old-fashioned book shelf or in the more modern social media platforms and web pages. Thanks also to Maury Solomon and her assistant Hannah Kaufmann at Springer New York for the belief and support they show with each title.

I send a heartfelt thank you once again to my Project Editor and brother Mike Shayler, whose editorial skills and sheer enjoyment of the English language always manages to evolve my scribbles and so-called final drafts into so much more. These books are a whole lot better because of Mike's wordsmith genius. Thanks also go to my 88-year-old mother, Jean, who still, after all these years, enthusiastically supports her family in whatever they do and displays the grit and determination to master even more computer and scanning skills to stop her from "feeling bored" in retirement.

They say every good man has a great woman behind him. I can certainly vouch for that in expressing my love and indeed sympathy to my wonderful wife Bel, who continues to "put up" with my book projects instead of contemplating "a quiet retirement," whatever that may mean! Finally, to Shado, as energetic and intelligent as a two-year-old German Shepard can be, always eager to drag me away from the computer to engage in more important and exciting pastimes like throwing balls, or taking long walks. Who said book writing was easy?

To all a big thank you once again, for allowing me to devote hours of attention to scribbling my accounts of human spaceflight for those who created the history, those who remember and witnessed it and those who can only learn about what has gone before but will hopefully be there to experience what is to come.

DEDICATION

To the NASA Astronaut Team
of
1959-1966

And specifically, to the first astronauts to fly Gemini:
Virgil I. 'Gus' Grissom (1926-1967)
&
John W. Young (1930-2018)

Also to the memory of
Group 3 pilot astronaut
Theodore C. Freeman (1960-1964)
A leading contender for an early Gemini assignment

And finally

To all the members of the Project Gemini ground team,
each of whom played their part in designing, developing, building,
managing, testing, processing, controlling and supporting
parts of the whole that finally allowed *Molly Brown*
to fly and fly well

…

As this book was being edited, news came through of the death, aged 101, of suit technician Joe Schmitt, who had suited up every American astronaut from Alan Shepard in May 1961 to the crew of STS-5 in November 1982.
Then, just a few weeks later, came the sad news that Gemini astronaut Richard F. ('Dick') Gordon Jr. (BUp Pilot Gemini 8, Pilot Gemini 11) had passed away at the age of 88.
This book therefore is also dedicated to Joe, as suit technician on all the Gemini missions, and Dick, the original 'Space Cowboy', with appreciation and sadness at their passing.

Foreword

As a spaceflight historian, author, and Project Mercury tragic, I had long aspired to write a series of books detailing each of the six flights in the Mercury program which carried the first astronauts on America's pioneering space missions. After some consultation with the good folks at Springer-Praxis, they agreed to publish the series and work began on the first volume, *Freedom 7: The Historic Flight of Alan B. Shepard, Jr.*, which was released in 2014. The six-book series was eventually completed two years later with the publication of the book on Gordon Cooper's 22-orbit flight aboard the *Faith 7* spacecraft.

It was around this time that my long-time friend and writing colleague David Shayler asked if I was planning to continue the series into the next program phase, by researching and writing similar books on each of the ten missions that flew under the name Project Gemini. This was something I had not seriously contemplated, especially as I was moving on to other book projects. With that established, David asked for my permission to take over the reins and produce a whole new series of books on the Gemini missions. I was more than happy to agree, knowing through long experience that David was eminently capable of producing an outstanding series of interesting and informative books. Especially as he would be able to explore and write about each flight and the astronauts involved in far greater depth than was possible when he wrote his seminal Springer-Praxis book, *Gemini: Steps to the Moon*, back in 2001 (republished in 2009).

The prime objective of the Mercury program was to test and establish whether a human being could survive the many and largely unknown rigors of space travel: the dynamics of lift-off, massive acceleration forces and the perils associated with the white-hot re-entry phase. In other words, that space travelers could live and work in space on missions of increasing length and complexity. Project Gemini had its origins in 1961 and was undertaken to provide a necessary bridge between Project Mercury and Project Apollo, which would hopefully place the first American astronauts on the Moon's surface before the end of the 1960s, as pledged by President John F. Kennedy.

Through its Gemini program, NASA would seek to develop and refine crucial techniques while conducting a series of low Earth orbital (LEO) missions. These would be flown between 1965 and 1966 in an incredible period of activity, which saw – on average – the launch of one crewed Gemini mission every two months. It was an outstanding feat of science and technology that saw the United States rapidly outstrip the efforts of the Soviet Union in the monumental Cold War race to the Moon.

As with Project Mercury, certain objectives were laid down for the more sophisticated two-man Gemini missions. These were:

- To demonstrate the endurance of humans, equipment and spacecraft systems during space missions extending up to a maximum of two weeks, sufficiently covering the eight days it would take for an Apollo journey to the Moon and back.
- To carry out rendezvous and docking with another orbiting vehicle and to practice maneuvering techniques of the combined spacecraft using the propulsion system of the target vehicle.
- To effect Extra-Vehicular Activity (EVA), or spacewalks, by exiting the confines and protection of the Gemini craft and to evaluate an astronaut's ability to perform manual tasks in the weightlessness of raw space.
- To enable engineers, controllers and astronauts to perfect techniques associated with atmospheric re-entry and touchdown at a pre-selected location.

Without any doubt, many people performed with magnificence and contributed to the amazing success that was Project Gemini. It was a truly momentous and enthralling period in spaceflight history. From a personal point of view, I can still vividly recall many times in my youth when I would be hunkered down in my bed well past the midnight hour, listening intently and with some trepidation to each Gemini launch on my little transistor radio. They were exciting times indeed.

It goes without saying that I am delighted David has decided to undertake this latest and important series project encompassing each of the twelve missions in chronological order. I know that he will not only provide a great and (as always) authoritative narrative, but one that all readers and historians will enjoy. This exciting story starts here with the two unmanned flights of Gemini 1 and Gemini 2, followed by the first manned flight of the series, the three-orbit mission of Gemini 3, more commonly known as *Molly Brown*. Flight by flight, with the Gemini 7 and 6 missions covered in one volume, the series will follow the trials and triumphs of Gemini from the first lift-off in April 1964 to the final splashdown thirty-one months later in November 1966. I know this will prove to be an exciting and interesting venture for you David.

Like so many others, I look forward to the day when I will have nine new and exciting books on my bookshelf as a tribute to your amazing work, talents, persistence and your dedication to continuing to record the absorbing history of human space exploration.

Colin Burgess,
Bangor, Australia
2017

Acronyms and Abbreviations

Distances used in the text (As per The Concise Oxford Dictionary, New Edition, 2003)

Mile (or statute mile)
A unit of linear measurement equal to 1,760 yards or 5,280 feet (1.609 kilometers)

Nautical Mile (or sea mile)
A unit of measurement of approximately 2,025 yards or 6,075 feet (1.852 kilometers).

Kilometer
A metric unit of measurement equal to 1,000 meters (approximately 0.62 miles).

Apogee
A point in an orbit where an object (in this case a spacecraft) is furthest from the Earth (the opposite of perigee).

Perigee
A point in an orbit where an object (in this case a spacecraft) is nearest to the Earth (the opposite of apogee).

Orbit
The path of a spacecraft under the influence of gravitational forces beginning and ending at a fixed point in space after completing 360 degrees of travel around a celestial body, in this case Earth. This, for clarity, is the term used in these books.

Revolution
A circuit of a celestial body, in this case the Earth, which begins and ends at a fixed point on the surface of that body. As Earth is *revolving* in the same direction as the trajectory of the orbital spacecraft (Gemini), this point in space moves further ahead, requiring the spacecraft to 'catch-up' and resulting in more than 360 degrees of travel in an orbit. Therefore, a revolution is about six minutes longer than an orbit. In the early days of the space program, the number of circuits around the Earth was originally given in orbits. Then Mission Control started to quote revolutions, which became confusing to the general public, so they switched back again. Today, the word 'orbit' continues to be the most commonly used term in recording the number of circuits of a spacecraft around the Earth (or other celestial body).

A word on Zero-g, or Weightlessness, or Microgravity
A long-term misnomer in space exploration concerns the terms 'zero-g' or 'weightlessness.' The motions of astronauts floating in space were described (for clarity, but incorrectly) as being in zero-gravity (or zero-g) or having no weight (weightlessness). In fact, there are gravitational forces at play in space and a more correct description would be 'microgravity', as those forces are there but are mostly negated by orbital motion. As an object (spacecraft) travels in the cosmos, apparently following a straight-line, it is also 'pulled' by the gravitational forces of celestial bodies. A spacecraft circulating around a celestial body is still being pulled towards it by gravity, but if that spacecraft is traveling fast enough, it achieves a state of continuous free-fall around that body. Thus, it is held in 'orbit' by a fine balance of motion and gravity until it either accelerates further to raise its orbit and achieve escape velocity, or decelerates to a lower orbit to begin the re-entry and decent to a landing.

A note on Gemini designations
The Gemini missions have been identified in different ways, including those which flew solo without an Atlas-Agena target and those which included an Atlas-Agena launch. Normally, the launch vehicle was also added to the description, thus: Gemini-Titan (abbreviated as GT-#) or with an Agena vehicle as Gemini-Titan-Agena (abbreviated as GTA-#) The flight numbers were often designated in Arabic numerals as Gemini 1 through 12, although NASA documentation of the time and the official accounts of the program used the Roman numerals I, II, III, IV, V, VII, VI, VIII, IX, X, XI and XII. To complicate this further, the original Gemini 6 and 9 missions were rescheduled and adopted the designations Gemini 6A (VI-A) and Gemini 9A (IX-A) when they flew. In these books, for clarity, the Arabic identification system has been adopted in most instances.

AC	Alternating Current
ACE	Attitude Control Electronics
ACME	Attitude Control Maneuver Electronics
AFB	Air Force Base
ANT	Antigua (secondary tracking station)
ASC	Ascension Island (secondary tracking station)
BDA	Bermuda (PRIMARY tracking station)
BECO	Booster Engine Cut-Off
BEF	Blunt End Forward (rear of the spacecraft facing the direction of flight)
CAL	Point Arguello, California (PRIMARY tracking station)
Cape	Cape Kennedy/Canaveral, Florida
Capcom	Capsule Communicator
CG	Center of Gravity
CNV	Canaveral (Cape Kennedy) Launch Control Center, Florida (PRIMARY tracking station)
COSPAR	Committee on Space Research (International)
CRO	Carnarvon, Australia (PRIMARY tracking station)
CSQ	*Costal Sentry Quebec* (PRIMARY tracking ship)
CTN	Canton Island (secondary tracking station)

CYI	Grand Canary (PRIMARY tracking station)
DAS	Data Acquisition System
DC	Direct Current
DCS	Digital Command System
DEI	Design Engineering Inspection
DOD	Department of Defense
ECS	Environmental Control System
EGL	Eglin Field, Florida (secondary tracking station)
ETR	Eastern Test Range, Florida
FAI	Fédération Aéronautique International
FDI	Flight Director Indicator
FIDO	Flight Dynamics Officer
g	Gravity (g) force
G&C	Guidance and Control
GBI	Grand Bahamas Island (secondary tracking station)
GET	Ground Elapsed Time
GLV	Gemini Launch Vehicle (Titan II)
GMT	Greenwich Mean Time (UK: Universal or 'Zulu' Time)
GMS	Gemini Mission Simulator
GPO	Gemini Project Office
GSFC	Goddard Space Flight Center (secondary tracking station)
GT	Gemini-Titan (launch vehicle)
GTA	Gemini-Titan-Agena (launch vehicle)
GTK	Grand Turk Island (secondary tracking station)
GYM	Guaymas, Mexico (PRIMARY tracking station)
HAW	Kauai, Hawaii (PRIMARY tracking station)
HF	High Frequency
HOU	Mission Control Center, MSC, Houston, Texas (PRIMARY tracking station)
IGS	Inertial Guidance System
IMU	Inertial Measurement Unit
IVI	Incremental Velocity Indicator
KNO	Kano, Nigeria, Africa (secondary tracking station)
LC	Launch Complex
LTV	Ling-Temco-Vought
MA	Mercury-Atlas
Max Q	Maximum Dynamic Pressure
MCC	Mission Control Center (HOU/Houston)
MDF	Mild Detonating Fuse
MDS	Malfunction Detection System
MECO	Main Engine Cut Off
MET	Mission Evaluation Team

MISTRAM	MISsile TRAcking Measurements
MOL	Manned Orbiting Laboratory (USAF)
MR	Mercury-Redstone
MSC	Manned Spacecraft Center (Houston, Texas)
MSFN	Manned Space Flight Network
MTR	Module Test Review
MUC	Perth, Australia (secondary tracking station) – used the same Callsign as former Mercury station at Muchea, Australia
NADC	Naval Air Development Center
NASA	National Aeronautics and Space Administration
NASCOM	NASA COMmunications
OAMS	Orbital Attitude and Maneuvering System
PAO	Public Affairs Officer
PCM	Pulse Code Modulation
POISE	Panel On In-Flight Scientific Experiments
PRE	Pretoria, South Africa (secondary tracking station)
R&R	Rendezvous and Recovery
RCS	Re-entry Control System
RGS	Radio Guidance System
RKV	*Rose Knot Victor* (PRIMARY tracking ship)
RR	Roll Rate
RRS	Retrograde Rocket System
RSS	Reactant Supply System
RTK	*Range Tracker* (secondary tracking ship)
SECO	Second Stage Engine Cut-off
SEF	Small End Forward (nose of spacecraft facing the direction of flight)
SEP	SEParation (from Titan booster)
SFRRB	Spacecraft Flight Readiness Review Board
SPADATS	SPAce Detection And Tracking System (USAF)
SST	Spacecraft Systems Tests
STG	Space Task Group
T	Terminal countdown either before (T-/minus/or down) or after (T+/plus/ or up) lift-off
TAN	Tananarive, former Malagasy Republic now Madagascar (secondary tracking station)
TETS	Thursday Evening Tanking Society
TEX	Corpus Christi, Texas (PRIMARY tracking station)
UHF	Ultra High Frequency
WETS	Wednesday Evening Tanking Society
WHS	White Sands, New Mexico, (secondary tracking station)
WLP	Wallops Island, Virginia (secondary tracking station)
WOM	Woomera, Australia (secondary tracking station)

Prologue
Molly Brown is on her way

"It looks nice"
Gus Grissom upon entering orbit.

March 23, 1965. Launch Complex 19, Cape Canaveral, Florida

> "*This is Gemini Control. T–2 minutes and counting. [with] a cross conversation going on between Gus Grissom and John Young on the various light positions. Everything is in a go condition… T–1 minute and 20 seconds… This is Gemini Control,"* reported Public Affairs Officer (PAO) Paul Haney. *"We're at T–1 minute, T–60 seconds and counting."* The first manned flight of a Gemini spacecraft was about to begin as Haney continued to check off the final seconds in the long count. *"T–45 seconds and counting. The range [is] holding a final status check, T–30 seconds. Recorders have gone to fast speed. Twenty seconds, fifteen seconds. Ten, nine, eight, seven, six, five, four, three, two, one, zero. Ignition…and we have a lift-off at 24 minutes after the hour. Rising very nicely. Cabin pressure climbing*." [1]

In his 1968 book *Gemini*, Grissom recalled these first few seconds of the mission. "There was a distant, muffled thunder ninety feet below our heavily insulated cabin. This was the split second during which our Malfunction Detection System had to warn me if something had gone wrong, and I had both hands on the ejection ring between my knees, ready to yank it hard if the MDS indicators on our instrument panel indicated we were in trouble." Seconds later, he glanced over to his pilot, who was not holding his ejection seat handle. [2] Despite his apparent trust in the rocket, Young was keeping a very close eye on the actions of his commander, as he related in an article following the flight: "I was watching you [Grissom] and if you'd pulled your ring a couple of times and nothing happened, I was sure going to yank mine hard." [3] It would be another 35 years before Young expanded upon his recollection of this, the first of seven rocket launches during his illustrious career. "Gus had flown MR-4 and knew what to expect, but I didn't have the foggiest notion." Young recalled that the noise in the cabin was not as loud as it had been in the simulator and that the lift-off was so smooth that it was not until he looked at the instrument panel that he realized they had left the pad. [4]

Just two seconds into the mission, Grissom reported that the onboard clock had started. This was followed ten seconds later by confirmation that the vehicle had begun its planned roll program and then by the pitch over at T+25 seconds.

On duty at Mission Control at the Capsule Communications (Capcom) console, Gordon Cooper acknowledged his fellow Mercury colleague's report with "*Roger. Pitch. You're on your way* Molly Brown." [5] It was important for Cooper to inform the crew of the actual lift-off, since it was so smooth, because if they had not been aware of the exact point of lift-off they would not have been prepared for the possibility of activating one of the more critical abort options, which occurred right at that time.

By the 60-second mark of the mission, the Titan was moving at a speed of 658 mph (1,059 kph), with the two astronauts, tightly strapped into their couches, experiencing 2 *g* as the point of maximum dynamic pressure (Max Q) on the vehicle was surpassed. With all systems reported in good condition inside the vehicle and three chase planes taking images of the outside, Gemini 3 soared spaceward. Young later commented that he felt they were "really hauling the mail," as the Titan gained speed. They were traveling three times as fast as Grissom had experienced on his first launch on a Redstone rocket, less than four years earlier.

"You're on your way *Molly Brown*." The March 23, 1965 launch of Gemini 3, carrying astronauts Virgil I. 'Gus' Grissom and John W. Young on the first of the program's ten manned missions.

Just two minutes into the ascent, Gemini 3 was fast approaching 3,000 miles per hour (mph, or 4,828 kilometers per hour, kph), imparting 3.3 *g* on the crew, who reported they were still in fine shape. Everything looked "Green for Go" in the Gemini control center as Capcom Cooper reported to the crew: "*You're a little high on the flight plan, but no problem* Molly Brown."

At 2 minutes 35 seconds, Grissom reported "*Go*" for staging. The shutdown of the twin first stage engines was followed just four seconds later by second stage ignition and thrusting, before the spent first stage was separated. This is referred to as a 'Fire in the hole'. For those few seconds the *g* loads eased, before building up again at three minutes into the mission as *Molly Brown*, perched on top of the Titan II second stage, was moving at a velocity of 6,500 mph (10,461 kph) and climbing fast.

Back on the ground, Mission Director Chris Kraft gave the crew a tentative "Go," but there was very little chatter from the two astronauts, who simply marked off the milestones in their flight plan as *Molly Brown* streaked space-wards.

Cooper: "*Looking good*."

Grissom gave a laugh in return and very calmly reported that they were starting to steer. They were flying a missile.

Grissom: "*Horizon comes right into view,*" he exclaimed as the vista caught his attention. "*Look at that horizon,*" he added, briefly admiring the view outside the window right in front of him.

At Ground Elapsed Time (GET) 4 minutes 35 seconds, *Molly Brown* was travelling at 12,000 mph (19,312 kph) and recording 3.5 *g*. The Flight Dynamics Officer (FIDO) reported an "excellent steering on this vehicle," with the combination in the primary guidance phase all the way to orbit.

"*You can see the view real well,*" Grissom reported on the clarity of his window, adding, "*the nose* [of Gemini 3] *dropped below the horizon a little bit, now it's back up above*."

There was a little distortion in Grissom's reports, but all were in the affirmative as milestones were quickly passed as the ascent continued. PAO Paul Haney stated that he thought the distortion was due to the communications system.

At 5 minutes 20 seconds, it was reported that the vehicle was approaching second stage engine cut-off. Then, just fourteen seconds later at 5 minutes 34 seconds, Mission Director Chris Kraft told Cooper to inform Grissom that they were given a "Go for separation." At the PAO console, Haney commented that aboard *Molly Brown*, Grissom reported he was "*very happy about that.*" At 6 minutes 10 seconds into the flight, Grissom confirmed: "*Okay. We are separated.*" *Molly Brown* was in orbit. It took about 15 to 16 seconds to separate to a safe distance from the booster. Gemini 3 was in excellent shape as they passed over Bermuda.

Pilot John Young, who had been very quiet up to this point during ascent, came onto the communication loop to report that "*the attitude was on the ball at 18 degrees nose down.*" Cape Capcom replied with confirmation of their orbit at "*87 [miles] by 125 [miles].*"

Grissom had become the first person to return to space and confirmed to his rookie pilot:

> "*That horizon is right where they said it would be.*" Young, never a man to waste words, replied simply, "*Yes.*"

Capcom Cooper then asked Grissom "*Does it look better from there than on a ballistic flight?*"

Grissom replied, "*It looks nice.*"

………

Fast forward to June 3, 1965, where Grissom and Young revisited the mission details during their technical crew debriefing, in this instance the launch phase. [6]

Grissom noted that the instrumentation on the booster performed as he expected, the two engine lights went off when ignition was called and he noticed a slow drop in fuel and oxidizer pressure. "When we got our roll program, we got roll rate. [But] I could see the roll by looking at the sky also. After lift-off, I could look at the sky and tell we were climbing, too."

John Young noted that he did not get much cue from the *g* forces at lift-off: "It's real, real soft," he said. Grissom concurred. "Lift-off is real soft. At staging, the booster was stable, and when the RGS took over, [the] booster pitched down real smoothly. I could feel those engines gimbal or kick around. It was all very smooth. In fact, the whole flight was smooth."

Neither man could recall feeling the hold down bolts blow at lift-off, as Grissom said: "My cues at lift-off were Gordo [Cooper] calling it, and the clock starting to run at the same time. It was just seconds after that, that I glanced out the window, and I could tell that we were climbing." It was so quiet that Young felt the actual lift-off noise was lower than that he associated with the Ling-Temco-Vought (LTV) simulator. Grissom again concurred. "The noise level was a lot lower. It was a lot less that we had at Vought. [The Titan II] is a real quiet bird." However, from BECO (Booster Engine Cut-Off) through SECO (Second Stage Engine Cut-Off), Grissom agreed that the Titan was "a little bit noisy," noting that they picked up some aerodynamic noise just prior to breaking the sound barrier. Grissom noted the transition to supersonic by the decreasing noise and by a little flap on the antenna cover vibrating when he looked out of his window. In fact, he was quite concerned at one point that the flap would break off and come right through the window. Fortunately, everything quietened down after going sonic and the flap remained in place. At BECO, both astronauts reported seeing a flame which came across their windows and debris drifting around, "like fire or something," Grissom recalled. "The mess scattered around anyway. But there was no doubt in your mind that you had started accelerating again." The transition was not as sharp as experienced during training, but was much smoother, steering the vehicle down below the horizon and then back up again. First-time flyer John Young was enjoying the view and admitted "I couldn't keep my eyes off the window." At the end of the first stage flight, Young noted a high-frequency vibration on the back of his headrest, but due to the acceleration forces the pilot could not raise his head to dampen out the effect.

Both pilots thought Max Q was actually very quiet, as Young observed: "I didn't notice any bucking, [or] adverse needle movement or anything. At BECO, the fire came around there [the windows] and surprised me. I don't know what happened. Then the [second stage] engines lit off. …Fire in the Hole. You might have expected it from looking at the [Gemini 2 movies], seeing these things at BECO, but I had never thought about it. This is smooth acceleration. It's really low acceleration. But that boy [the Titan] pitched over and she was really picking up speed towards the end. Oh boy, that's really something. I couldn't keep from looking out the windows, so I kind of neglected my attitude [readings]."

Young then commented on the computer error FDI display, which indicated a 2- to 3-degree pitch down during the first stage boost. He thought it was a very smooth, steady steering period all the way through the first stage and was not really concerned, otherwise, he admitted, he would have told someone about it. Then, just as he was about to inform the ground about the pitch error, Cooper came on the radio and said the booster was indeed going high, which was the first indication Young had had. Cooper told the astronauts that it was nominal and there was nothing to worry about, so Young chose not to comment. Grissom noted that if Cooper had not informed them of the deviation, they would have been concerned.

When asked about jettisoning the scanner fairing after orbital insertion, Grissom commented "You could hear those things. I saw it pop off. The antenna fairing goes at the same time and it really makes a noise when it leaves, [and it leaves] junk all over the place. There are springs and pieces of metal flying every place. You could see some springs out in front of us for a good bit … there is no doubt in your mind that both of them [the fairings] are gone. The only thing that concerned me was some of that debris." Grissom said he was not worried about collision with the debris, but was concerned that some of the bits might get back into the scanners. He added "If one of those springs or pieces of debris got into a scanner head, you lose a scanner. I think it's a good idea to have the covers on."

Young raised a concern about moving his hands towards the SEP switches under *g* loads, noting "If you ever hit the wrong one it would be a natural disaster." Grissom casually pointed out that that was why they were locked, at which point Young said that he had noted that fact.

At SECO, Grissom forgot what time the burn had started, "so I just burned until I knew I had burned long enough," noting at the end that "the nose of the spacecraft was right on the horizon," precisely where it should have been.

Neither man could hear the firing of the aft OAMS thrusters during the separation of the Gemini from the spent Titan, even though Young was carefully listening out for them before he hit the switch. However, both men clearly heard the pyrotechnics fire to separate the spacecraft physically from the booster. "That's very clear," recalled Grissom, while Young described the event as sounding "like a 105-mm howitzer back there." Grissom continued: "So you know when you have separated. The only thing that concerned me was that I wasn't sure if we were thrusting." Then, just as in training, the spacecraft pitched down, forcing Grissom to use the pitch up control. This told him that the CG (center of gravity) was in the right spot. He controlled the roll rate, which he thought was high, but he soon damped it out and it stopped.

"When we separated," recalled Young, "all this stuff comes flying up over the windscreen. I never saw anything like it." Grissom likened the debris to shrapnel, but it disappeared very fast, moving out beyond them.

Both astronauts noted that the ride was smooth, without major vibrations or high noise levels. Then, at SECO, Young punched off the separation switch and, as Grissom recalled, "We got a good strong boot in the tail. There's is no doubt about it. Noisy, and a fair amount of debris flying around the spacecraft." In fact, there was so much debris flying around outside, it drew Young's attention.

In the post-fight news conference, held appropriately enough in the Gemini Room at the Carriage House Motel at Cocoa Beach, Florida two days after their flight, Young expanded upon his first views out the window of the Earth spreading out in front of him: “The view out of the window was unbelievable. You can’t take your eyes away from that window in the first few seconds of weightless flying. It’s incredible. There aren’t words in the English language to describe the beauty I felt [during] the last part of powered flight. I was supposed to monitor the Inertial Guidance System performance but … it’s just a tremendous effort to get your head back in the cockpit and look at those instruments. I think it’s the sort of thing that one is really fortunate to be able to get to do. I was impressed.” [7]

As impressed and distracted as Young may have been on his first spaceflight, there would be no time on this short mission to admire the view out the window for long, as the flight plan was pretty full and they would be challenged as they progressed through it. Almost immediately, Grissom found an unexpected left drift in the spacecraft which was puzzling. That would not be all in this demanding test flight. The crew would experience difficulties in keeping the temperature down, as well as in steadying the ‘8-ball’ flight director indicator and the horizon sensor, all while they were trying to evaluate crew systems and the habitability of the crew compartment. But this was a test flight and uncovering such issues was the point of flying just three orbits prior to embarking on much longer missions.

Then there were issues in defining the control of Gemini prior to the move to the new Mission Control Center on the next flight. The Titan launch vehicle also flew “too hot,” with more power than expected, while the re-entry proved “too mild” and affected the targeted landing. But there were lighter moments too, making Gemini 3 a memorable mission in ways neither the crew or NASA had envisaged.

Molly Brown was just the third Gemini mission and the only manned test flight of the program. With so much to do on this mission and with great plans in place for the nine to follow, this flight and the astronauts were expected to deliver results straight away. It was now time to get down to work, to achieve the stated primary objective for this mission of being able to maneuver in space, to deliver upon the promise of Gemini laid out just four years earlier and to build upon the two unmanned flights which had preceded this one.

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1

Mercury Mark II

"If there had been no Mercury program,
there would be no Gemini program;
if there had been no Gemini program,
there could be no Apollo program."
Virgil I. 'Gus' Grissom, *Gemini*.

For a long time, Gemini was a program overshadowed by the achievements of Apollo (1960-1975) and the initial American manned space program, Project Mercury (1959-1963). Now, however, it is seeing a resurgence of interest in its operations, half a century after the missions were flown. One reason for its relative anonymity is that Gemini was an intense but short-lived program, created in the early 1960s and matured over just three years. It was operational for just over 30 months and, despite grand plans, was all over by the end of 1966. Nevertheless, NASA's second manned space program was an indispensable lynch-pin between America's pioneering days with Project Mercury and the efforts to place the first humans on the Moon during Apollo. It also provided the groundwork for more extensive manned spaceflight operations, by developing key procedures that had application far beyond the Moon program of the 1960s. Gemini richly deserves recognition for its contributions both to the American program and to the global development of human spaceflight.

Gemini was created to serve a purpose and, despite a somewhat shaky start, achieved almost all that was expected of it. Those who worked on the program retained an affection for it that lasted far longer than the program itself. As Gus Grissom, who had helped to nurture the spacecraft to operational status, wrote shortly before he tragically lost his life, without Gemini, born of Mercury, there would have been no Apollo; at least, not as history records and certainly not as smoothly as the six missions demonstrated between October 1968 and November 1969, as they reached for the Moon during a spectacular year of achievement.

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Playing catch-up

The Gemini program was created to meet an immediate need in the American space program: to gain experience in regular spaceflight operations. Project Mercury had proved that man could be launched into space aboard a one-shot space 'capsule', could perform some basic, useful work there and could survive the fiery re-entry to return to Earth, or more accurately water, with a splashdown in the planet's large oceans.[1] By the time the Gemini program was formally initiated, the United States had already been set the national goal of "landing a man on the Moon and returning him safely to the Earth" by the end of the decade. The historic speech by U.S. President John F. Kennedy on May 25, 1961, was made partly in response to the recent – and to a degree embarrassing – one-orbit flight of Soviet cosmonaut Yuri A. Gagarin aboard the spacecraft Vostok, as well as the disastrous CIA-led invasion at the Bay of Pigs against the communist-led island of Cuba.

In order to achieve Kennedy's goal, Gemini would first have to prove that longer spaceflights were possible, that rendezvous and docking could be achieved and that spacewalking, given adequate preparation and equipment, could be mastered. Since the American program was open to the world, Gemini would offer this evidence to other nations wishing to address these issues.

However, that was in the future. Back in the early 1960s, America was severely lacking in space leadership; so much so that the Soviets would grab most of the world's headlines in the first eight years of the space age: (1957) the first satellite and the first living creature (the dog, Laika) in orbit; (1959) the first lunar probe (Luna), the first object to reach another celestial body (the Moon with Luna 2) and the first spacecraft to pass behind the Moon and take images (Luna 3); (1961) the first man in space (Yuri Gagarin) and the first 24-hour manned spaceflight (Gherman S. Titov); (1962) the first dual flight (Vostok 3 and Vostok 4); (1963) the first long-duration flight (five days, Vostok 5) and the first woman in space (Valentina V. Tereshkova, Vostok 6); (1964) the first space 'crew' (three cosmonauts aboard Voskhod 1); (1965) the first spacewalk (Alexei A. Leonov on Voskhod 2).

It was not until the program of ten manned Gemini missions, launched on average at three-month intervals between March 1965 and November 1966, that America finally began to overhaul the Soviet lead in the so-called space race. It was Gemini that allowed the Americans to develop the procedures needed not only to reach the Moon, but to establish a routine access to space, supported by pinpoint recovery and an extensive ground infrastructure. Five decades after the Gemini program concluded, these systems, together with the previously mentioned rendezvous and docking, spacewalking and long-duration spaceflight techniques, are precisely the same ones employed to keep the International Space Station flying.

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[1] The early astronauts always preferred the term space 'craft' rather than space 'capsule'. As most of them were seasoned pilots, they reasoned you could operate or fly a 'craft', but would usually take a 'capsule' for medical reasons.

THE ORIGINS OF A PROGRAM

Five years before a Gemini spacecraft left the launch pad, the possibility of such a program was explored during a meeting of a NASA committee chaired by Harry J. Goett of the Ames Research Center. During the two-day meeting, held over May 25 and 26, 1959, the committee evaluated the idea of enlarging the design of the one-man Mercury spacecraft by fifty percent to accommodate two astronauts for two to three days. The idea of an upgraded Mercury spacecraft was appealing not only to NASA but also to prime contractor McDonnell, as Mercury was severely limited for anything beyond supporting the solo pilot for up to one day, with little opportunity to perform scientific experiments and no capability for either maneuvering or leaving the spacecraft in orbit.[2]

In August 1959, while McDonnell looked into what would be required to modify the basic Mercury design, elements of the Space Task Group (STG) began to look more seriously at an even more advanced Mercury-type spacecraft. On August 12, the STG's New Projects Panel requested the group's Flight Systems Division to begin studies of a second-generation manned spacecraft that had significant improvements over the original Mercury. By April 1961, a number of new systems had been proposed for this advanced Mercury spacecraft, most notable of which were the inclusion of a re-entry control navigation system to improve the accuracy of landing and the installation of controls to allow the crew to perform a rendezvous in orbit with a second vehicle.

Enter Apollo… and Vostok

The idea, indeed the desire, to develop a large spacecraft to support an advanced space program that would include manned flights to the Moon, had its initial support in the late 1950s, both in the military and at NASA. During the same STG meeting in August 1959, discussions into the idea of improving the Mercury spacecraft ran parallel to the New Project Panel's focus upon the future manned program and a proposed second-generation, three-man capsule. This would include the "potential for near-lunar return velocities," in other words flights around the lunar far side – more commonly known as circumlunar trajectories – and would use the new large Saturn launch vehicle. On July 25, 1960, as these studies continued, the name 'Apollo' was chosen for the advanced three-man spacecraft, with plans to utilize them to support manned lunar landings and to service a permanent space station.

In February 1961, McDonnell held discussions with NASA about how they envisaged improving the design of Mercury to include a second astronaut. In fact, these studies pointed to two different versions of the advanced Mercury spacecraft. Firstly, minimal changes would be made to the basic Mercury spacecraft, allowing one astronaut to fly for 18 orbits (27 hours, or 1 day). More significant changes would be required to improve the design sufficiently to support two men on more advanced missions and this clearly pointed towards a brand new spacecraft. For a while, this improved concept became known as Mercury Mark II, instead of Advanced Mercury, based upon the suggestion of STG

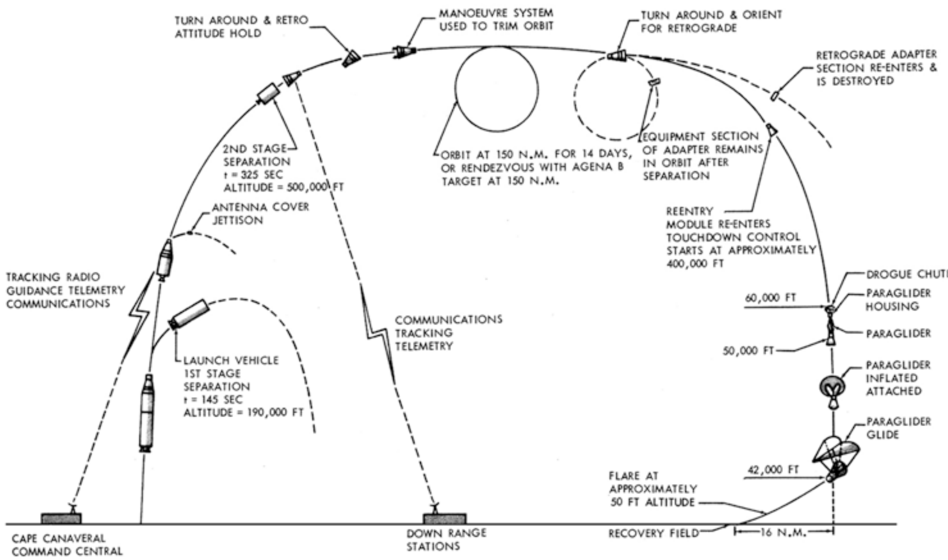
[2] McDonnell Aircraft (founded in 1939), the primary contractor of the Mercury and Gemini spacecraft, merged with the Douglas Aircraft Company in 1967 to form McDonnell-Douglas, which was subsequently acquired by Boeing in 1997.

contracting officer Glenn F. Baily and John Y. Brown of McDonnell Aircraft Corporation. On April 14, 1961, just two days after Yuri Gagarin became the first man to fly in space, NASA issued a study contract to McDonnell for improving the Mercury spacecraft. Plans were being put in place for far more advanced missions even before the basic one-man design had flown with an astronaut on board.

In the aftermath of the historic single-orbit flight of Yuri Gagarin in Vostok, the global headlines hailing the achievement echoed through the hallowed halls of NASA and the White House. Over the next few weeks, the best course of action to respond to the clear lead the Soviet Union held over America in space was debated. Their first response came on May 5, 1961, in the 15-minute suborbital flight of Alan B. Shepard aboard Mercury 3/*Freedom 7*. Although Shepard had not attained orbit, at least America could claim they had their first 'spaceman'. It was a start, albeit a small one. While NASA and the White House debated a more appropriate, bold response to the Soviet successes and the perceived strategic threat, representatives from the Martin Company, which had built the Titan missile system for the USAF, briefed NASA officials on May 8 (just three days after Shepard's flight) about the potential of using the Titan as a launch vehicle for future manned spacecraft. Two months later, as Virgil 'Gus' Grissom flew the second American suborbital mission aboard Mercury 4/*Liberty Bell 7*, NASA received a proposal from Martin that outlined utilizing the Titan to boost the advanced Mercury II spacecraft into orbit. Titan would be a much more powerful vehicle than either the Redstone that had been used for the suborbital Mercury missions or the Atlas planned for the orbital flights.

During May, another advanced idea also gained support as a potential objective for Mercury Mark II. On May 17, 1961, a statement of work was issued to Goodyear Aircraft Corporation, North American Aviation Inc. and Ryan Aeronautical Company to develop the concept of a paraglider landing system (known as the Rogallo Wing) to control a manned spacecraft to a descent on land, rather than a costly ocean splashdown. Barely a week later, on May 25, President Kennedy spoke before the U.S. Congress, calling for new, bold, long-range plans for the nation's space program, including the landing of a man on the Moon by the end of the decade. Within NASA, it was clear that there would be much to do to achieve this target and with only 15 minutes on the U.S. manned spaceflight log book, an immediate need was identified to develop a series of flights which were not part of the Apollo program, but which could support the lunar effort by developing the procedures necessary for Apollo to be able to meet President Kennedy's deadline.

One of the decisions to be made in order to send Apollo to the Moon was exactly how to achieve the flight profile. Three leading methods were evaluated. Direct Ascent (DA), where the whole vehicle would be sent straight to the lunar surface, would require a more massive vehicle than currently under development, whereas Earth Orbital Rendezvous (EOR) would see separate elements of the "moon ship" assembled in Earth orbit before making the lunar voyage. Then there was Lunar Orbital Rendezvous (LOR), where only part of the spacecraft would be used for the landing while the larger mother ship remained in lunar orbit. This would obviate taking all the return fuel, supplies, heat shields and engines to the surface, saving weight on the lander and easing the performance requirements on the lander's ascent engine for leaving the surface. Both EOR and LOR would involve extensive capability for proximity operations, which would require close-formation flying of more than one spacecraft, as well as rendezvous and docking to bring two separate spacecraft together and join them up mechanically and safely to allow the transfer of astronauts and equipment between them. The LOR method was eventually chosen for Apollo in 1962, with the Command and Service Module (CSM) mother ship accompanied by the Lunar Excursion Module (LEM; the word 'Excursion' was later dropped and the module was simply known as the LM, though it was still pronounced as "LEM"). The flight profile debate had identified the need for Mercury Mark II to master the techniques of rendezvous and docking in Earth orbit before trying it with Apollo either in Earth orbit or around the Moon.



Early diagram of the Gemini mission profile, including a 14-day mission duration, a docking with an unmanned Agena B target vehicle and the planned land-landing, subsequently revised to an ocean splashdown. EVA (spacewalking) was not indicated at this point.

By the end of 1961, the plans for Mercury Mark II were becoming clearer and a definitive program was emerging. On December 7, NASA Associate Administrator Robert C. Seamans approved the development plan for a two-man spacecraft launched by the USAF Titan II. It would be capable of much longer missions than its historic predecessor, possibly up to two weeks, which was thought to be the most suitable duration for sending a manned mission to the Moon, performing a landing and short stay and returning to Earth. A second air force launch vehicle, the Atlas which would also be used to launch the Mercury orbital missions, would carry an Agena B target vehicle (later changed to Agena D) into orbit to provide a suitable target for the Mercury Mark II manned spacecraft to perform rendezvous and docking exercises with in Earth orbit. Another stated objective for this program was the development of the land-landing capability.