PIONEERS IN EARLY SPACEFLIGHT

GEMINI 5

EIGHT DAYS IN SPACE OR BUST

David J. Shayler

PRAXIS

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Front Cover: Astronauts L. Gordon Cooper (left) and Charles "Pete" Conrad Jr. are seen in the Gemini 5 spacecraft in the White Room at Pad 19, just after insertion into the spacecraft on the morning of August 21, 1965 and shortly before the start of their eight-day mission. [Credit: NASA]

Back Cover: Main image: On the deck of the USS *Lake Champlain*, an elated Pete Conrad tweaks the week's growth of beard on Gordon Cooper's chin shortly after recovery on August 29, 1965. The two astronauts had set a new space endurance record of eight days and, in surviving the discomfort, confirmed that it would be possible to endure a similar length mission to the Moon on Apollo. [Credit: NASA]

Inset: The front cover design for the author's next book in this series, featuring the missions of Gemini 6, 7 and 8 and the quest to achieve a 14-day space marathon, as well as finally docking with the uncrewed Agena target vehicle. [Credit NASA]

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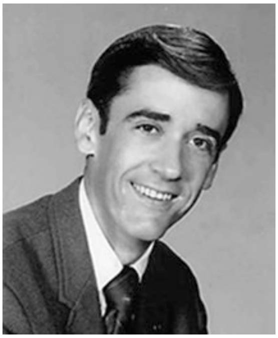
Foreword

For the men in Mission Control (sorry, but there were no women back then), Gemini 5 was a giant challenge. Not only was it a challenging long duration mission, but the flight plan included two particularly important space firsts: fuel cells rather than batteries for power generation and a space rendezvous with a pod.

In addition, it would be the first flight from the Houston Mission Control Center (MCC) with no back-up from the Mercury Control Center at Cape Canaveral. Even though the new MCC had the capability to display a lot more data, with console call-up displays, a huge rear-projection screen in the center of the room and large TV displays on either side of the big screen, it was still new and somewhat unfamiliar. The displays were digital, not the customary analog. One of the new things was the pneumatic tube system that allowed us to send messages to the Real Time Computing Complex, our staff support room and to all the other controllers in the Mission Operations Control Room. Even though the data could be displayed on the rear-projection screen, the Flight Dynamics team brought in the old-style plot boards – like we had used at the Cape – and placed them in front of the big center screen, because we were not sure the new-fangled digital displays would work. For those of us who had worked at the Cape, the whirring noise of the plot boards made us feel more comfortable.

Unfortunately, soon after the rendezvous pod was deployed, the flight crew saw that the pressure in one of the fuel cells had dropped drastically and decided to turn them off. With only battery power available, the rendezvous would not be possible. This was a great disappointment for the Flight Dynamics team. Astronaut Buzz Aldrin, who had a doctorate degree from MIT in orbital mechanics specializing in space rendezvous, proposed a "phantom" rendezvous. Gemini V could just rendezvous with a given point in space. My reaction to this proposal quickly went from "That's a crazy idea," to "That's a wonderful idea." So, we chose a state vector representing the altitude, latitude, longitude, azimuth and velocity of a phantom target and carried out a remarkably successful rendezvous on day three of the mission. It went perfectly.

The remainder of the mission was filled with more problems with the fuel cells and the Orbital Attitude and Maneuvering System. We did, however, make it to the planned eight-day duration. Retrofire was initiated over Hawaii and they landed about 80 miles (128.7 km) short of the planned recovery point in the Atlantic. This was by far the longest mission we had flown and therefore the first time that we encountered a problem with a computer constant which said that the Earth rotated 360 degrees every 24 hours. It rotates 360.98 degrees. Just another step in the learning curve leading to Apollo.



Jerry Bostick. [Credit: Jerry Bostik and NASA]

Jerry Bostick

Flight Dynamics Officer (FDO, pronounced 'FIDO'), Gemini 5.

Subsequently, Chief, Flight Dynamics Branch, which consisted of the Retrofire Officer, Flight Dynamics Officer and Guidance Officers, responsible for the trajectory and guidance of the spacecraft.

Dedication

To the crew of Gemini 5
Leroy Gordon "Gordo" Cooper (1927–2004)
&
Charles "Pete" Conrad (1930–1999)

This book is also dedicated to
Gemini Blue Shift Flight Director
John Denis Hodge (1929–2021)

And to the memory of
William Gustov Krauss (1933–1965)
Boatswain Mate 2nd Class, USN
USS *Chipola* (AO-63)

Author's Preface

In the late 1990s, when asked by Clive Horwood of Praxis Books for new ideas for future titles in the company's space exploration portfolio, I suggested (among other titles) an overview of the Gemini program, which I felt had been overlooked by the publishing world for some time. To me, Gemini represented a turning point in early space exploration by addressing key issues that would become important elements of future space flight: sustaining a human crew on long duration missions beyond a few hours or days; developing the techniques and understanding of orbital rendezvous and docking between two vehicles in space; and the exploration of spacewalking, or more correctly Extra Vehicular Activity (EVA).

The Gemini program, flown between April 1964 and November 1966, provided experiences in all three of those elements and added a fourth by conducting a range of experiments and investigations across number of scientific and technical fields. In addition, there were new lessons learned in handling multiple (and at times, rapid) launches from the same pad, controlling more than one vehicle in orbit simultaneously, and establishing a successful method of selecting, training and supporting a cadre of astronauts to fulfill these ambitious plans.

That book, *Gemini Steps to the Moon*, was published by Springer-Praxis in 2001, and was followed by many others in the series. But there was always a desire in the back of my mind to return to Gemini someday and expand upon the limited content one can dedicate to an entire program in a single volume.

There was so much more to explore in Gemini and, over a decade later, the opportunity arose to do just that. When my good friend (and co-author on three other Springer titles) Colin Burgess informed me that he was not intending to continue a mission-by-mission account beyond his six excellent

Mercury titles, I suggested to Springer a series of nine books, initially, covering all 12 Gemini flights. As daunting as this sounded and indeed first appeared, my initial research rekindled the magic of human spaceflight I had first discovered almost 50 years earlier as a teenager, when I had followed every mission of Apollo day-by-day. The difference now was that I had access to the air-to-ground commentary, official post-mission reports and other documentation, which made following the missions on paper (my preferred medium) almost as exciting as watching events unfold on TV. In the first book of the series, I explained the intention, book by book and mission by mission, that a rewarding series of adventures would unfold, explaining the program that gave the Americans the experiences and confidence to press ahead with Apollo and reach the surface of the Moon just 32 months after the last Gemini mission came home. Ironically, that was just one month longer than the timescale of the entire Gemini program.

Under the subtitle *Pioneers in Early Spaceflight,* the first book, *Gemini Flies* (2018) featured the two unmanned test flights and the pioneering three-orbit mission of Gemini 3, aka *Molly Brown*. Later that same year, *Gemini 4: An Astronaut Steps into the Void* focused on the first American spacewalk by Ed White and the extended four-day mission. This, then, is the third title and explores the challenging eight-day flight of Gemini 5 that fulfilled most, but not all of the main objectives of the program. One important element, rendezvous and docking, remained unaddressed and that was reserved for the next mission, Gemini 6. The book covering that mission would also include the final push for a 14-day space marathon on Gemini 7. These were planned as a single title because both ended up flying simultaneously at the end of 1965. The missions of Gemini 8 through 12 would then follow in sequence. At least, that was the plan in 2019 when the draft for this book was being written. But other factors took over, not least a global pandemic, necessitating a serious re-examination of the series by Springer.

The current plan (2022) is to combine Gemini 6 and 7 as originally planned, but with the addition of Gemini 8 in an enlarged volume subtitled *Chasing Agena*, with the rendezvous and docking objective of Gemini finally achieved along with the 14-day endurance record. Then, instead of separate works, the final four missions of Gemini will be encompassed in one larger volume subtitled *Prelude to Apollo*, in which the various aspects of rendezvous and docking in relation to Apollo and beyond will be explored. The working cover for the first of these new titles is displayed on the back cover of this book. This change has also presented the opportunity to explore other aspects of Gemini in greater depth in the future.

What did not change were the plans for this book, *Gemini 5*, and the efforts made by men and machine to attain the desired eight-day goal, the planned duration of an early Apollo mission to the Moon and back.

Gemini 5 was not only an important step on the road to the Moon, but a further small increment in gradually increasing the length of human spaceflights, to a point where, a decade after Gemini stopped flying, humans could confidently plan and perform missions of several months in duration. Of course, in the late 1970s and for the next two decades, the leaders in long duration spaceflight were the Soviets, with their initially troubled but ultimately phenomenally successful series of Salyut and Mir space stations. Having abandoned the Moon in the early 1970s, the Americans also squandered their hard earned experience from Skylab, their *only* national space station to date, to focus on creating a supposedly reliable, economic and routine access to space called the Space Shuttle.

Gemini 5 pushed the envelope in so many areas. Flight duration was clearly foremost, along with further attempts at rendezvous, even if it was with a phantom target. Then there were the experiences in working with the fuel cells, the decision to cut power and create long periods of drifting flight, and how not only to recover the flight plan, but also to support the flight crew in challenging circumstances that no one had previously experienced in space. Gordon Cooper held the duration record from his solo flight in Project Mercury and extended his total with Gemini 5, if only for four months, while Pete Conrad, a rejected candidate for the Group 1 astronaut intake because of his apparent unsuitability for long term spaceflight, called Gemini 5 a week "in a garbage can", which basically it was. Conrad would later fly aboard Skylab to set a new American record of 28 days, over three times the Gemini 5 duration. A lot was learned on Gemini 5, which had direct application for the planned rendezvous mission of Gemini 6 and the long duration mission planned for Gemini 7. But there were also the Earth observation activities, and the fact that the Americans had finally beaten the Soviet record by three days. There was certainly much to celebrate with Gemini 5.

Halesowen, UK David J. Shayler

Acknowledgements

As with each title written, a considerable network of contacts, colleagues and resources is necessary to achieve the end result. This current project was no different and, like each book project undertaken, the time involved to progress from proposal to finished product rarely passes as smoothly as initially planned. But that is one of the challenges of writing these types of account; there is so much involved in ensuring a fair, accurate and informative finished product, not only by the author but with a whole production team.

Once again, I must thank my friend, colleague and esteemed author Colin Burgess, both for suggesting I tackle the Gemini series of missions for Springer in the first place and for supplying copies of the 1965 Australian press accounts of the flight, thereby offering a third angle to approach the mission in addition to the normal US and British coverage.

Thanks are also given to Eddie Pugh, who provided his notes on the mission for an article intended for the now long-defunct *Space Flight News* magazine, which helped timeline events and reports more precisely. All images are courtesy of NASA unless otherwise stated. For those rare and additional images, thanks go once again to Ed Hengeveld, whose treasure trove of new and little-known NASA images is a goldmine.

I must also thank former Flight Dynamics Officer Jerry Bostick for his excellent Foreword, recalling first-hand the events of the flight in Mission Control Houston as Gemini 5 flew during August 1965. For additional information and insight into the Gemini rendezvous process, I appreciate the help of John Goodman, formerly of United Space Alliance, and Ken Young, NASA Mission Analysis Division (1964–67) and member of the Gemini 5 Rendezvous Team, for his personal recollections of the background to recovering the rendezvous experiment for the mission.

For the production of the book, thanks go once again to Clive Horwood of Praxis Books, for his continued support and the encouragement of his author team over the past 20 years since my first book with the Praxis portfolio. Clive's enthusiasm and dedication to each project, author and production process has been an inspiration and encouragement time and time again.

At Springer, thanks go to Hannah Kauffman for believing in the project and for her professional advice and suggestions along the way. Once again, the cover design is thanks to Jim Wilkie, who converted my original ideas into the professional sleeve you see here. It is also part of the fun and pleasure to be involved with the title and cover design of each book project and to see them evolve along with the text of the project. Thanks also to the team of reviewers who saw the potential for this title, and indeed the series.

For the professionalism and sheer magic of his wordsmith skills, I am indebted to my brother Mike Shayler, who can naturally mold a rough draft into the professional masterpiece you see here. What Mike sees and understands about crafting a smooth end result is nothing short of a miracle. It always amazes me to see any book project grow from rough ideas, notes and discussions, through each process, to arrive at what can be picked up off a bookshelf (always the most rewarding way) or downloaded to a modern platform.

On a more personal note, I must again thank my wife Bel for once more putting up with my efforts in creating this book over many, many months, and finally ticking another contracted title off the long list before… retirement? Thanks also to my mother, Jean Shayler, who continues to support her family fully in everything we do and actively wishes to participate in any way she can, even if her accumulated solar orbits have reduced the pace, though not the passion, of her efforts. And finally to Shado, our wolf in dog's clothing, who, after nearly six years, still thinks life is still a game for both dogs and humans, and whose adventures and antics continue to raise a smile even during these most difficult of times for us all.

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 measure 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. Orbits are referred to in this book when reflected in the mission commentary and references.

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). For clarity and historical accuracy, revolutions have also been used throughout this book, reflecting the commentary during the mission

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 Cut-Off
BEF	Blunt End Forward (rear of the spacecraft facing the direction of flight)
CAL	Point Arguello, California (PRIMARY tracking station)
Capcom	Capsule Communicator
Cape	Cape Kennedy/Canaveral, Florida
CG	Center of Gravity
CNV	Canaveral (Cape Kennedy) Launch Control Center, Florida (PRIMARY tracking station)
CRO	Carnarvon, Australia (PRIMARY tracking station)
CSQ	*Coastal Sentry Quebec* (PRIMARY tracking ship)
CTN	Canton Island (secondary tracking station)
CYI	Grand Canary (PRIMARY tracking station)
DAS	Data Acquisition System
DC	Direct Current
DCPS	Dynamic Crew Procedures Simulator
DCS	Digital Command System
DOD	Department of Defense
ECS	Environmental Control System
EGL	Eglin Field, Florida (secondary tracking station)
EST	Eastern Standard Time (GMT -5 hours)
ETR	Eastern Test Range
FAI	Fédération Aéronautique International
FDI	Flight Direction 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)
GMS	Gemini Mission Simulator

GMT	Greenwich Mean Time (UK: Universal or 'Zulu Time')
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
Max Q	Maximum Dynamic Pressure
MCC	Mission Control Center (HOU/Houston)
MECO	Main Engine Cut-Off
MET	Mission Evaluation Team
MOL	Manned Orbiting Laboratory (USAF)
MSC	Manned Spacecraft Center (Houston, Texas)
MSFN	Manned Space Flight Network
MSOB	Manned Spacecraft Operations Building (Kennedy Space Center, Florida)
MUC	Perth, Australia (secondary tracking station) – used the same Callsign as former Mercury station at Muchea, Australia)
NADC	Naval Air Development Center, Johnsville, Pennsylvania
NASA	National Aeronautics and Space Administration
NASCOM	NASA Communications
O&C	Operations and Checkout (Building, Cape Kennedy, Florida)
OAMS	Orbital Attitude and Maneuvering System
PAO	Public Affairs Officer
POISE	Panel On Inflight Scientific Experiments
PRE	Pretoria, South Africa (secondary tracking station)
R&R	Rendezvous and Recovery
RCS	Re-entry Control System
REP	Rendezvous [or Radar] Evaluation Pod
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 Cut-off
SEDR	Service Engineer Department Report
SEF	Small End Forward (nose of spacecraft facing direction of flight)
SEP	SEParation (from Titan booster)
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)
TEX	Corpus Christi, Texas (PRIMARY tracking station)
UHF	Ultra High Frequency
WHS	White Sands, New Mexico (secondary tracking station)
WLP	Wallops Island, Virginia (secondary tracking station)
WOM	Woomera, Australia (secondary tracking station)

Prologue

The October 1965 NASA Fact Sheet on the Gemini 5 flight stated that "*The period August 21–29, 1965, will go down in history as the one in which the United States broke a number of existing manned space flight records – in fact, a period during which a number of manned space flight records were established.*" Such was the significance of the mission.

The earlier Gemini press kit, released on August 12, 1965, stated that the goals of this third crewed mission of the series were to:

1. Demonstrate and evaluate the performance of the Gemini spacecraft for a period of eight days.
2. Evaluate the performance of the rendezvous guidance and navigation system using the Radar Evaluation Pod [also called Rendezvous Evaluation Pod].
3. Evaluate the effects of prolonged exposure to the space environment on the two-man crew.

The eight-day duration was determined to be the optimum mission length for an Apollo crew to fly to the Moon, explore its surface and return to Earth. As the official press kit indicated: "*Gemini 5 is expected to demonstrate that the intended weightlessness of a manned Moon landing mission is not a threat to the health of the crew and that well-conditioned, well-trained astronauts can perform effectively over the duration of such a flight.*"

So, Gemini 5 was to tread the water for Apollo, and in preparation for even longer missions being planned. Secondary objectives assigned to the flight included the "demonstration of a controlled re-entry to a predetermined landing point."

Half a century later, today's space missions regularly log months onboard the International Space Station (ISS), conducting a wide range of multi-national scientific research programs, pushing the barriers of long space missions far beyond eight days to many months, developing new technologies and procedures, and probing the adaptation of the human organism to prolonged flights in low Earth orbit as a precursor to the first deep-space sojourns towards the asteroids or Mars.

But back in the summer of 1965, human spaceflight was barely four years old and even the dawn of the space age had yet to celebrate its eighth anniversary. In human terms, a mere dozen orbital missions had circled the Earth between April 1961 and August 1965[1] ranging in duration from 108 minutes to five days, with most lasting just a few hours from launch to recovery as humans learned how to survive in the hostile environment. The database of human exposure to orbital spaceflight included 19 subjects (18 male and just one female), with two short exposures to the challenges of spacewalking (formally known as Extra Vehicular Activity or EVA).

This was a remarkable advance given the standing start and limitations of the equipment, but with Gemini 4 completed and the fourth anniversary of U.S. President John F. Kennedy's pledge to put an (American) man on the surface of the Moon by the end of the decade (1970) in sight, there remained just five and a half years left to achieve that target. Given that the optimum launch window (to ensure adequate lighting conditions) to send a spacecraft to the Moon with a crew occurred for only a few days each month, there were just 66 chances to turn the promise into reality. Every four weeks, another of those opportunities slipped by.

It was not just the huge investment required, as President Kennedy had stated in his famous speech at Rice University in 1962, just three years earlier:

> "*The exploration of space will go ahead, whether we join in it or not, and it is one of the great adventures of all time, and no nation which expects to be the leader of other nations can expect to stay behind in the race for space…*
>
> *"But why, some say, the moon? Why choose this as our goal? And they may well ask why to climb the highest mountain? Why, 35 years ago, fly the Atlantic? Why does Rice play Texas?*
>
> *"We choose to go to the moon. 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, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win, and the others, too…*

---

[1] Not counting the two Mercury sub-orbital flights and the seven X-15 astro-flights.

> *"But if I were to say… that we shall send to the moon, 240,000 miles away from the control station in Houston, a giant rocket more than 300 feet tall, the length of this football field, made of new metal alloys, some of which have not yet been invented, capable of standing heat and stresses several times more than have ever been experienced, fitted together with a precision better than the finest watch, carrying all the equipment needed for propulsion, guidance, control, communications, food and survival, on an untried mission, to an unknown celestial body, and then return it safely to earth, re-entering the atmosphere at speeds of over 25,000 miles per hour, causing heat about half that of the temperature of the sun – almost as hot as it is here today – and do all this, and do it right, and do it first before this decade is out – then we must be bold*".

And so, in 1962, President Kennedy had underlined the effort required by the nation to achieve the goal he had set a year previously, one he would not live to see fulfilled, but which was still being supported by President Lyndon B. Johnson's Administration in spite of escalating tensions at home and the developing conflict in southeast Asia.

Then there were the Soviets, the apparent leaders in the 'Space Age', who had orbited the first satellite and the first living creature (the dog *Laika*), and had sent the first probes to the Moon. The Soviets could also claim the first man and first woman in space, the first 'crew' and the first spacewalk. Despite a huge propaganda machine and the apparent ease of their multiple 'space firsts', the truth behind the headlines told a different story, one that was only revealed years later. Behind the scenes, the Soviet program was struggling with leadership, finance and hardware issues. What may have been proclaimed as great Soviet communist advances were in fact fortunate successes – historic achievements certainly, built upon years of effort and devotion, but also on opportunity and luck. Despite the grandiose claims and predictions made by the Soviets in the summer of 1965, the truth remained hidden from the West. Not that this took anything away from the challenge laid down by President Kennedy and the risks the American space program faced with the plans for Gemini 5. What had been termed the 'arms race' between the two superpowers had manifested into a 'space race' and was now very much a 'Moon race'. No-one at that time realized that the race would be a one-sided contest.

Despite this, the hurdles were real and daunting. In the summer of 1965, the focus for Gemini 5 was not to master the techniques of rendezvous and docking with a target – though preliminary work was to be done in that field – nor to extend the experience of working outside a spacecraft. Instead, the main purpose of Gemini 5 was to test man and machine in a one-week mission. There would be a selection of experiments to occupy the astronauts, but it was also intended to make them encounter and endure the tedious boredom of single-vehicle spaceflight, even this early in human spaceflight history.

According to the official Gemini 5 Mission Report, the flight was launched just 11 weeks after the highly successful four-day mission of Gemini 4, and concluded after eight days. The crew of Gordon Cooper and Charles Conrad had "completed the mission in excellent physical condition and demonstrated full control of the spacecraft and competent management of all aspects of the mission." The primary objectives were attained, though there were a few issues to overcome. The two astronauts had demonstrated it was possible to sustain an orbital flight of eight days and had evaluated – albeit with added challenges – the performance of the rendezvous and navigation system. They had "evaluated the prolonged exposure of a flight crew to the space environment in preparation for missions of longer duration." Unfortunately, the oxygen supply levels in the fuel cell had decreased just 45 minutes into the rendezvous experiment, so the decision was made to power down the spacecraft and therefore abandon the planned rendezvous with the evaluation pod. There followed a concentrated effort by ground staff, both in Mission Control and with the contractors, to establish a suitable and safe operating mode to continue the mission, constantly changing the flight plan in real time to support the various experiments and maintaining a strong desire to complete the full eight-day mission safely. Of the 17 experiments planned, 16 were conducted successfully despite the inflight challenges, with a high percentage of data attained. Post-flight evaluation of the mission determined that Gemini 5 had attained all primary and secondary objectives, with three exceptions: evaluating the rendezvous and guidance system in conjunction with the Rendezvous Evaluation Pod (though subsequently they were successfully able to conduct a 'phantom' rendezvous); demonstrating the capability of either astronaut to maneuver the spacecraft in orbit in close proximity with another object (which was not possible due to the decision to power down the spacecraft); and the inaccuracy of the attempted controlled re-entry which resulted in a splashdown 219.7 miles (353.5 km) off track and 89.3 miles (143.7 km) short of the planned landing point.

Command Pilot Gordon Cooper became the first person to return to orbit and the second Mercury pilot to fly twice (after Gus Grissom, whose first flight was sub-orbital), just two years after he had been the last man to fly a Mercury spacecraft. Pete Conrad was on his first mission, having failed to be selected as a Mercury astronaut himself as he was considered "unsuitable for long duration missions." Six years later, here he was about to embark on one of the most difficult missions yet.

Gemini 5 was certainly a difficult mission, not in the complexity of its objectives or activities, but in keeping the crew sane while spending eight days inside the close confines of the Gemini spacecraft. As Pete Conrad later recalled, the experience was similar to spending "eight days in a garbage can."

Whichever way you look at it Gemini 5 was a challenge.

1

Pushing the Envelope

"Rendezvous would soon be so essential that the technology should be developed immediately and NASA should make experiments to develop the technique and establish the feasibility of rendezvous."
– The consensus of the Inter-NASA Research and Space Development Center's Discussion on Space Rendezvous, Langley Research Center, May 16–17, 1960.

During the first two days of February 1967, just four days after the loss of the Apollo 1 astronauts in the fatal fire on Pad 34, NASA held its Gemini Summary Conference at the Manned Spacecraft Center (MSC) in Houston, Texas. Designed to emphasize the highlights of the recently completed Gemini flight program, this symposium presented the results from the final five missions and updated the findings presented in the Mid-Program Conference held a year earlier (February 23–25, 1966). The 21 technical papers presented were broken into five sections and, in the section dealing with rendezvous, docking and tethered vehicle operations involving the spacecraft and a target vehicle, the presentation by W. Bernard Evans of the Office of Vehicle and Missions, Gemini Program Office, NASA MSC, and Marvin R. Czarnik, Dynamics Group engineer, McDonnell Douglas Aircraft Corporation, stated:

> "One of the major objectives of the Gemini program was to develop and to demonstrate techniques for the rendezvous and docking of space vehicles. This objective is of vital importance for the success of many future [crewed] spaceflight programs. For example, lunar orbital rendezvous has been selected as the primary mode for the Apollo lunar-landing mission, which requires one

D. J. Shayler, *Gemini 5*, Springer Praxis Books,
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> rendezvous and two dockings. Other programs requiring rendezvous are planetary missions, manned space station and unmanned satellite inspection and repair missions".

For Gemini, a range of rendezvous techniques were developed. (This will be explored in more depth in the forthcoming *Chasing Agena*, David J. Shayler, Springer-Praxis.) The statement continued: "A major factor in achieving success during these [docking] operations can be attributed to the implementation of an extensive analysis, simulation and training program". This led to the rendezvous between Gemini 6 and 7 and the docking of Gemini 8. It was also recognized that the step-by-step approach followed on earlier missions had greatly added to the experience and confidence in the Gemini-Agena rendezvous and docking system:

- Gemini 3 had evaluated the spacecraft propulsion system and the guidance and control system, as well as the astronaut life support system.
- For Gemini 4, a plan was developed, and an attempt made in flight, to station keep and rendezvous with the spent second stage of the Titan II launch vehicle.
- Finally, during Gemini 5, a phantom rendezvous and spacecraft radar-to-ground transponder tracking tests were performed. "The phantom rendezvous involved a series of maneuvers based upon ground tracking and computations, and precisely duplicated the maneuver sequence and procedures planned for the mid-course phases of the Gemini 6A mission".

Despite the in-flight difficulties encountered during the Gemini 5 mission, the report went on to state that sufficient data was obtained from the radar tracking test to flight-qualify the radar for subsequent flights. The summary concluded with the statement: "Even though the rendezvous operations planned for the first three manned Gemini flights were not all successful, each were extremely valuable to the program since they provided flight experience and indicated areas requiring further analysis, simulation and training".

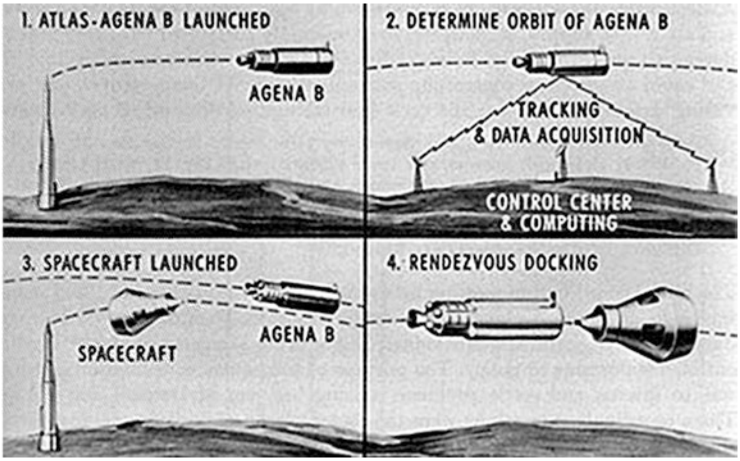
While the "eight days or bust" objective and the challenges from the new fuel cell system created the headlines of Gemini 5, the work in implementing and conducting the phantom rendezvous experiment, after losing the Rendezvous Evaluation Pod (REP), is largely overlooked. But that was of equal importance in the long-term analysis of the flight and in the early development of space rendezvous and docking techniques. Such techniques are still used today, more than half a century after they were first evaluated on Gemini 5.

Looking back, some 57 years after flying the mission, it is difficult to imagine the mood and apprehension in the summer of 1965 as the launch approached. The flights of Gemini 3 and 4 had helped to create confidence in the machinery, but to go from four days to eight in one mission was a big leap. That was the duration planned for the first crewed Apollo to fly to the Moon, achieve a landing, have the astronauts perform a short surface exploration to collect a few rocks and deploy simple experiments, and then get safely back to Earth. Longer, more complex missions would follow if the first mission was a success, but it all depended upon further flight evidence from Gemini that the chosen path was the right one. Gemini 5 was a major step forward in that goal. There was also the fact that the Soviets held the space endurance record (at nearly five days), so to surpass that would be an added boost to the program and to national prestige.

In 2000, former Flight Director Gene Kranz reflected upon the apprehension in pushing for the eight-day target in his autobiography, *Failure is not an Option*: "Both inside and outside NASA, doctors had expressed doubt that man could adjust to life in zero gravity. Some went as far as to predict that exposure for a long period would probably be fatal, but astronauts continued to confound the physiologists and the doomsayers". Kranz also recalled the reports coming in from the Russians at various medical conferences, which cited reported problems in "adaptation, crew performance and post-mission recovery."

It is important to remember that at that time, 1965, there had been only six US and eight Soviet orbital missions. On the 14 occasions humans had been in orbit, their flight time had ranged from 108 minutes to just short of five days, and none of the crews had really experienced the freedom of weightlessness in large spacecraft that we are accustomed to witnessing today. Equally, the subject of 'space sickness', which we now term Space Adaptation Syndrome, was little understood. As the launch of Gemini 5 drew near, the apprehension was quite high because it was this flight which would provide the confidence to fly the much-anticipated and planned 14-day space marathon on Gemini 7 just four months later. A lot rested on Gemini 5 making it to the full eight days. A deeper examination of the development and importance of early space medicine will be featured in the next title in this series, *Chasing Agena*, which will look at the medical aspects of the 14-day mission more fully.

As well as reaching the eight-day objective, there was a desire to attempt more rendezvous operations with a free-flying target prior to trying a full-blown rendezvous and docking with the much larger Agena. There had been attempts at rendezvous and station keeping with the spent rocket stage during Gemini 4, which exposed issues with remaining in close proximity to the stage and would require more investigation [1]. It was hoped that Gemini 5 would explore those issues in advance of the pioneering docking mission of Gemini 6.



A 1962 image showing the planned four-stage rendezvous with an Agena B target vehicle. [Credit: NASA]

A Rendezvous in Space

The idea of expanding space operations beyond a single, crewed spacecraft had existed for decades before the first satellite reached orbit in October 1957. Part of this development was the idea of combining more than one vehicle in space to explore deeper into the solar system, a dream that had long been in the minds of theorists, as well as science fiction writers in books and, more recently, movies. However, the practicalities of this would have to wait until it had been proven that a vehicle could be placed in orbit, that the vehicle could support human life, and that a system had been devised to maneuver the vehicle and bring it into close formation flight in space, eventually joining it to another to make a larger vehicle, either permanently or for the short term.

Today, in the opening decades of the 21st century, we know these operations as human spaceflight, where rockets transport crewed space vehicles to and from Earth orbit to support the crew while away from the Earth in orbit around the planet, on return trips to the Moon and, hopefully in the near future, on to deep space or other planets. The 'science' of bring together more than one vehicle in space has been termed 'rendezvous'; that of keeping them in close formation as 'proximity operations'; and that of joining or separating