

NASA GEMINI 1965-1966 (ALL MISSIONS, ALL MODELS)

An insight into NASA's Gemini spacecraft, the precursor to Apollo and the key to the Moon. Owners' Workshop Manual series

By D Woods and D M Harland

Haynes Publishing, Sparkford, Yeovil, Somerset BA22 7JJ, UK. 2015. 172pp. Illustrated. £22.99. ISBN 978-0-85733-421-3.

On 25 May 1961 President John F Kennedy made to Congress the historic commitment "of achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to the Earth" nine months before the first American had even orbited the Earth (John Glenn, February 1962). Huge advances were needed to achieve JFK's goal, most obviously the need for a much more powerful rocket than then available – the Saturn V being the eventual answer to that. A more subtle area of advancement needed was the ability of two spacecraft to rendezvous in space. The option of building a truly enormous rocket and getting to the Moon and back directly was soon realised to be impractical. Wernher von Braun and his team in Huntsville Alabama wanted to launch two separate vehicles into Earth orbit using his proposed Saturn V rocket and combine them in space to get to and from the Moon. A third approach seemed to be the most cost effective involving a rendezvous in orbit around the Moon whereby the vehicle to return to Earth stayed in lunar orbit while a much smaller vehicle descended to the surface and an even smaller one returned. Whether in Earth or lunar orbit it became clear that space rendezvous would be needed and the Gemini series of missions grew from this realisation. The third approach was, of course, the one eventually adopted, requiring only a single Saturn V rocket per mission.

The Haynes 'Owners' Workshop Manual' series is well known to car and motorcycle owners, helping them to maintain and repair their vehicles. The Gemini member of this series is one of a dozen or so dedicated to space vehicles, such as Apollo 11 and 13, the Hubble Space Telescope, the Space Shuttle and the International Space Station. The intention of course is not to enable you to repair the vehicle but to provide an engineering description accessible to the non-specialist. This reduced scope explains why a further sub-set of the Haynes series deals with fictional vehicles such as the *Millennium Falcon* from *Star Wars* and the *USS Enterprise* from *Star Trek*.

The Haynes format works well for the Gemini spacecraft. The authors have enhanced the uncomplicated text by including clear diagrams and

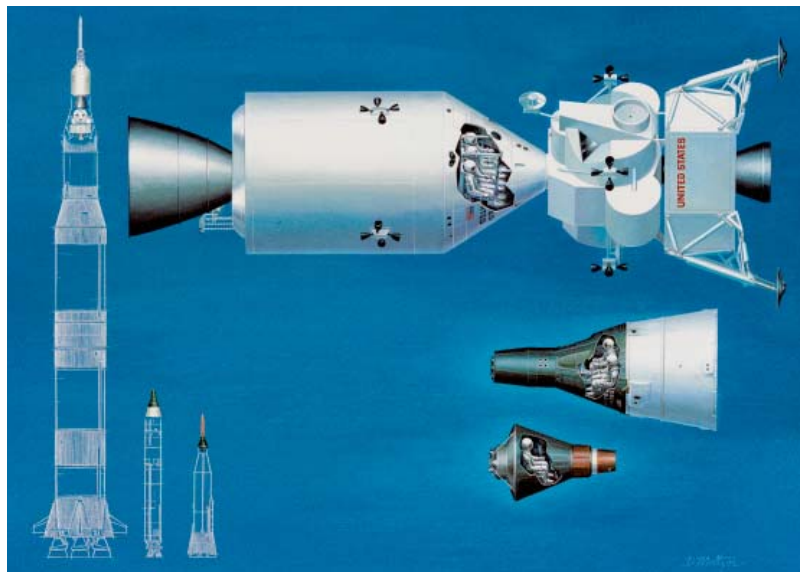


Figure 1. Illustration of the relative sizes of the one-man Mercury spacecraft, the two-man Gemini spacecraft and the three-man Apollo spacecraft. Also line drawings of their respective launch vehicles: Atlas-D, Titan II and Saturn V showing their relative size to each other and the position of the spacecraft at launch (highlighted at top).

Nearly every aspect of Gemini was a significant advance on the unsophisticated Mercury including the addition of an onboard computer (albeit with just 12,000 words of memory and weighing 25kg)

images throughout. The main subsystems of the Gemini spacecraft are described, as are the other systems employed including the Titan II rocket, the Agena upper stage target and the astronauts' space suits. Each of the 12 Gemini missions is discussed, including the rationale for its objectives as well as the actual flight experience.

The step up from the 1.4 ton Mercury capsule represented by 3.8 ton Gemini is discussed in detail. Figure 1 shows the larger Gemini dimensions that carried two astronauts instead of Mercury's one, alongside the almost 50 ton three-person Apollo. Nearly every aspect of Gemini was a significant advance on the unsophisticated Mercury, including the addition of an onboard computer (albeit with just 12,000 words of memory and weighing 25kg), a total of 36 thrusters to provide attitude and orbit manoeuvrability, horizon sensors, and fuel cells to enable Gemini to power itself for a fortnight. One feature of Mercury that was retained for both Gemini and Apollo was the truncated cone shape of the re-entry vehicle – and the authors point out that, 50 years on, it is still in use for 21st century space vehicles such as SpaceX's Dragon and NASA's Orion.

Gemini 6 required four orbits of the Earth to rendezvous with Gemini 7 in December 1965 (Figure 2). Progress was such that, nine months later, Gemini 11 used the same amount of propellant to rendezvous with its Agena target in a single orbit. Gemini 7 also demonstrated the ability to remain in space for the 14 days that would be needed for a Moon landing and Gemini 11 took humans to an altitude of 1,400km for the first time – a distance not exceeded until the Apollo 8 mission into lunar orbit at Christmas 1968. These are just a few of the many 'firsts' achieved by Gemini and related in this book and in general the *Gemini Owners' Manual* is successful in documenting

how experience gained in terms of equipment and procedures was fed into the Apollo programme and played no small part in its eventual success.

The pleasure of reading the book is heightened by the anecdotes and insights it contains of which the following are just a small sample. Today's space missions are in constant communication with the ground but Gemini did not benefit from the relay satellites in geostationary orbit that make this possible. Instead the astronauts had sporadic contact with mission control whenever they passed over a NASA ground station – typically 5 to 10 minutes duration over each station. The authors note that “to the public at large flying in space was exciting and glamorous but the reality of spending so long in an inert craft was an ordeal in boredom.” Gemini required substantially more astronaut involvement than Chuck Yeager's ‘spam in a can’ description of the Mercury crew as related in Tom Wolfe's *The Right Stuff*. The authors describe many of the hair-raising and complicated situations encountered during the Gemini missions, not least Neil Armstrong's quick thinking response to the once per second (and accelerating) rotation of Gemini 8 in March 1966 caused by a faulty thruster.

This is a well-written and presented addition to the Haynes series and will appeal to anyone with an interest in the engineering challenges of the Apollo Moon landing programme. It covers an important



Figure 2. Gemini 7 in orbit alongside Gemini 6 from which this image was taken about 290km above the Earth on 15 December 1965. NASA.

bridging phase in the Apollo adventure that is often forgotten but that was indispensable in enabling the US to achieve the ambitious goal set by JFK in 1961 as well as being an exciting programme in its own right.

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HUMAN FACTORS MODELS FOR AVIATION ACCIDENT ANALYSIS AND PREVENTION

By T G C Griffin *et al*

Ashgate Publishing Limited, Wey Court East, Union Road, Farnham, Surrey GU9 7PT, UK. 2015. 226pp. Illustrated. £65. ISBN 978-1-4724-3275-9.

This book argues for the systems-thinking approach to accident and incident investigation. As such it is very much ‘on message’: bodies like the International Civil Aviation Organization (ICAO), the European Aviation Safety Agency (EASA) and the UK's Civil Aviation Authority (CAA) all recommend the holistic, systems-thinking-informed approach to investigation.

Pioneered by The Honourable Mr Justice Virgil P Moshansky in his investigation of the 1989 Dryden accident, where a Fokker F28 crashed due to icing, this approach emphasises the often complex, relational and opaque origins of adverse events. Having surveyed Canada's commercial aviation ‘network-space’, Moshansky concluded: “This accident was the result of a failure in the air transportation system.” Griffin, Young and Stanton's book accepts Prof James Reason's claim that information degradation, non-availability, miscommunication or misinterpretation is frequently the trigger for mishap. Based on original research conducted both in the

Of the many valuable observations, one stands out: that in the absence of disasters, incidents provide a valuable insight into the health of complex socio-technical systems like aviation

laboratory and in the field, the authors offer a novel systems-analysis tool based on Bayesian precepts. Specifically, the tool attaches probabilistic risk assessments to pilots' decisions/actions. The tool can be applied retrospectively and prospectively.

Of the book's eight, well-illustrated chapters, I found Chapter 1 (Introduction) and 2 (Modelling a Dynamic World) the most useful, simply because they provide a long-overdue concise history of the development of the systems-thinking approach to incident and accident investigation. Of the many valuable observations, one stands out: that in the absence of disasters, incidents provide a valuable insight into the health of complex socio-technical systems like aviation. As, thankfully, disasters become less frequent, the authors make an eloquent case for incident-centrism in risk-assessment: “Incidents work well to populate the information networks, and key to their use is to identify the potential outcomes, and the reasons for a more positive outcome than an accident” (p 201). Viewing incidents through Prof Brian Toff's Active Learning prism will save lives.

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TUPOLEV TU-128 'FIDDLER'



By A Dawes *et al*

Fonthill Media Limited, Millview House, Toadsmoor Road, Stroud GL5 2TB, UK. 2014. 464pp. Illustrated. £35. ISBN 978-1-78155-404-3.

Surgey Burdin and Alan Dawes MRAeS previously co-operated in a book on the *Tupolev Tu-22 Blinder* (Pen and Sword. 2006). For this book they are joined by Nikolai Popov, a former Tu-128 pilot. The assistance of a number of Soviet Air force personnel, involved with the Tu-128 during its service career is acknowledged. The Tu-128 was a dedicated long-range interceptor designed to protect the northernmost regions of the USSR from US intrusion.

Unlike a number of aircraft histories, this book concentrates on the operational aspects of the Tu-128's service life, rather than the technical development of the aircraft which is dealt with in 34 pages. However, its predecessors, which include the Lavochkin La-250A, do get a mention, including, in particular, the Tupolev Tu-98 supersonic bomber prototype, which was used as a systems prototype.

The Tu-128 was originally designated the Tu-28, and was specifically intended to operate over a wide radius of action, in co-operation with ground radar and Tupolev Tu-126 airborne early warning aircraft. A brief history of its development is illustrated with a number of photographs, some of which are disappointingly grey in tone.

The second chapter deals with the aircraft's pivotal role in the Tu-128S-4 weapons system for the USSR's integrated long-range airborne interception system involving computer-assisted radar guidance and Bisnovat R-4 (AA-5 'Ash') missiles. The flight navigation equipment is listed and explained in considerable detail. The cockpit pressurisation and ventilation system is dealt with briefly in Chapter 3 and the crew life support systems in Chapter 4.

Chapter 5 describes the initial operational

Tupolev Tu-128 at the Central Air Force Museum at Monino, Russia.

experience with the Tu-128 and bemoans the lack of a fighter-trainer at this date (1965), which was dealt with by using an Ilyushin Il-14 airliner to give fighter pilots experience in a large and heavy aircraft. This aircraft was later replaced by a Tupolev Tu-124 airliner pending development of the Tu-128UT trainer in 1971, dealt with in Chapter 7. Chapter 6 explains the USSR's fighter regiment structure and Chapter 8 covers aircrew training in the 1970s and 1980s. Chapter 9 explains the technique for flying the Tu-128, while Chapter 10 covers operations in various climatic conditions, where the weather in the Arctic caused considerable problems.

The operational aspects covering the bases and tasks of the Tu-128 regiments are covered in Chapter 11 and Chapter 12 deals with the ground-controlled interception techniques in considerable detail. Chapter 13 explains how operations in the Soviet high Arctic were managed. The Tu-128 regiments participated in regular tactical flight exercises and these are explained in chapter 14 which also covers the USSR's response to the USA's automatic drifting reconnaissance balloons in the pre-satellite era. Chapter 15 covers the aircraft's final years of operations.

There are 100 pages of appendices covering the first detailed photograph of the Tu-128, taken in June 1972 by the USAF. Other appendices cover performance data, accidents involving the Tu-128 and its operational limitations.

There are a number of colour photographs, mainly of museum aircraft and a single page of colour drawings. Modellers would have appreciated detailed five view drawings. The Tu-128 is not dealt with in such detail in any other book of which this reviewer is aware, in either English or Russian, and is recommended to those interested in Soviet Cold War aircraft.

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