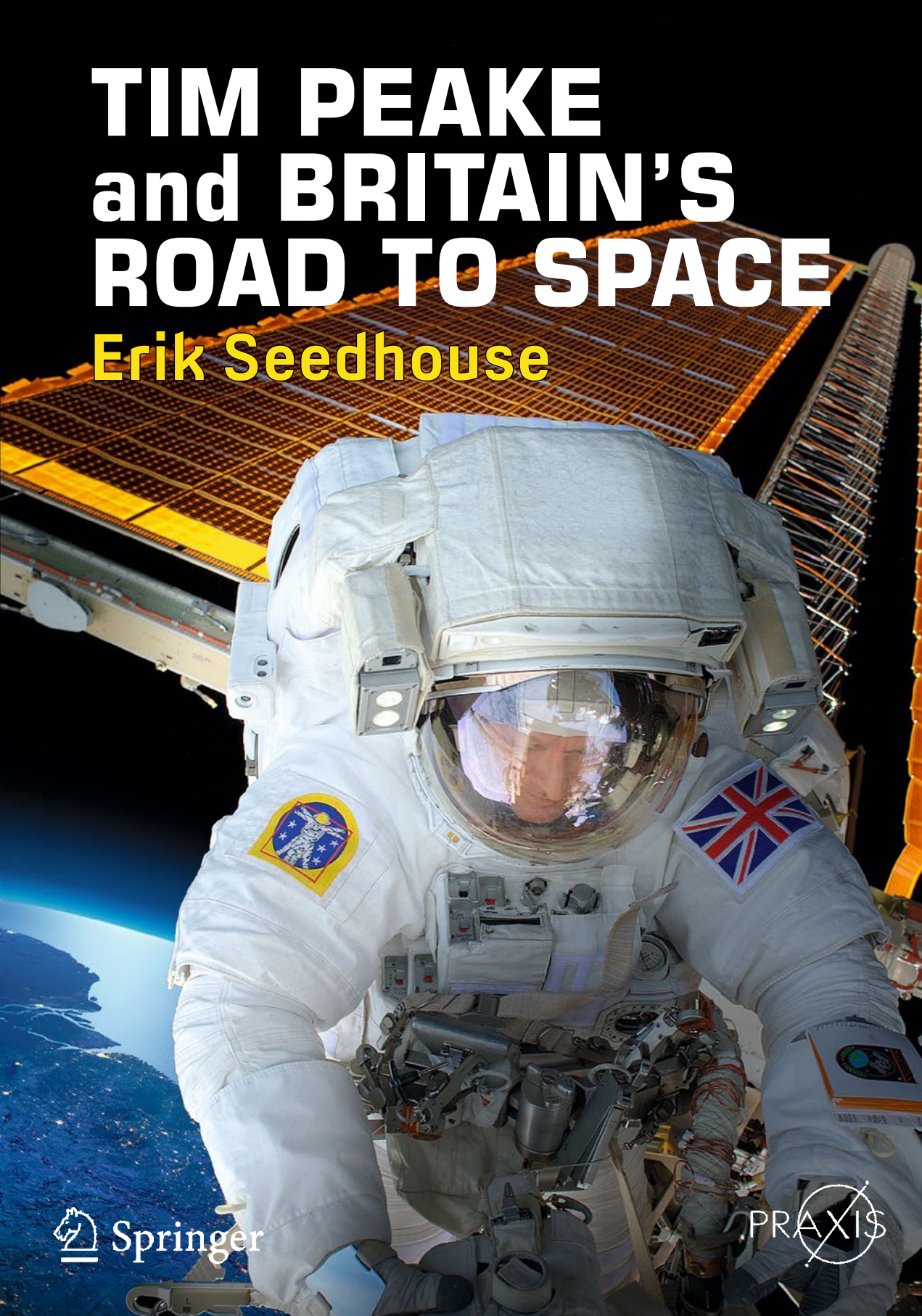
TIM PEAKE and BRITAIN'S ROAD TO SPACE

Erik Seedhouse



Springer

PRAXIS

Tim Peake and Britain's Road To Space

Erik Seedhouse

TIM PEAKE and BRITAIN'S ROAD TO SPACE

Springer

Published in association with
Praxis Publishing
Chichester, UK

PRAXIS

Erik Seedhouse
Assistant Professor, Commercial Space Operations
Embry-Riddle Aeronautical University
Daytona Beach, Florida
USA

SPRINGER-PRAXIS BOOKS IN SPACE EXPLORATION

Springer Praxis Books
ISBN 978-3-319-57906-1 ISBN 978-3-319-57907-8 (eBook)
DOI 10.1007/978-3-319-57907-8

Library of Congress Control Number: 2017950171

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

Printed on acid-free paper

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

Contents

Acknowledgements

In writing this book, the author has been fortunate to have had five reviewers who made such positive comments concerning the content of this publication. He is also grateful to Maury Solomon at Springer and to Clive Horwood and his team at Praxis for guiding this book through the publication process. The author also gratefully acknowledges all those who gave permission to use many of the images in this book and also to Project Manager, Sasi Reka, for guiding this manuscript through the final stages of publication. The author also expresses his deep appreciation to Michael Shayler, whose attention to detail and patience greatly facilitated the publication of this book and to Jim Wilkie for creating yet another striking cover. Thanks Jim!

To
Alice

About the Author

Dr. Erik Seedhouse [from the author's collection]

Erik Seedhouse is a fully-trained commercial suborbital astronaut. After completing his first degree, he joined the 2nd Battalion the Parachute Regiment. During his time in the 'Paras', Erik spent six months in Belize, where he was trained in the art of jungle warfare. Later, he spent several months learning the intricacies of desert warfare in Cyprus. He made more than 30 jumps from a Hercules C130 aircraft, performed more than 200 helicopter abseils and fired more light anti-tank weapons than he cares to remember!

Upon returning to academia, the author embarked upon a Master's degree which he supported by winning prize money in 100 km running races. After placing third in the World 100 km Championships in 1992, Erik turned to ultra-distance triathlon, winning the World Endurance Triathlon Championships in 1995 and 1996. For good measure, he won the World Double Ironman Championships in 1995 and the infamous Decatriathlon, an event requiring competitors to swim 38 km, cycle 1800 km, and run 422 km. Non-stop!

In 1996, Erik pursued his PhD at the German Space Agency's Institute for Space Medicine. While studying, he found time to win Ultraman Hawai'i and the European Ultraman Championships, as well as completing Race Across America. Due to his success as the world's leading ultra-distance triathlete, Erik was featured in dozens of magazine and television interviews. In 1997, GQ magazine named him the 'Fittest Man in the World'.

In 1999, Erik took a research job at Simon Fraser University. In 2005, the author worked as an astronaut training consultant for Bigelow Aerospace. Between 2008 and 2013, he served as Director of Canada's manned centrifuge and hypobaric operations. In 2009, he was one of the final 30 candidates in the Canadian Space Agency's Astronaut Recruitment Campaign. Erik has a dream job as an assistant professor at Embry-Riddle Aeronautical University in Daytona Beach, Florida. In his spare time, he works as an astronaut instructor for Project PoSSUM, an occasional film consultant to Hollywood, a professional speaker, a triathlon coach and an author. 'Tim Peake' is his 27th book. When not enjoying the sun and rocket launches on Florida's Space Coast with his fiancée, Alice, he divides his time between his second home in Sandefjord and Waikoloa.

Acronyms and Abbreviations

ACE	Advanced Colloids Experiment
AES	Advanced Exploration Systems
ATA	Ammonia Task Assembly
ATV	Automated Transfer Vehicle
BEAM	Bigelow Expandable Activity Module
BEO	Beyond Earth Orbit
BIS	British Interplanetary Society
BNSC	British National Space Centre
BRT	Body Restraint Tether
CAVES	Cooperative Adventure for Valuing and Exercising human behavior and performance skills
CETA	Crew and Equipment Translation Aid
CIDS	Circuit Interrupt Devices
COLBERT	Combined Operational Load Bearing External Resistance Treadmill
COSPAR	Committee on Space Research
CPS	Consolidated Planning System
CSA	Canadian Space Agency
CSF	Cerebrospinal Fluid
DCM	Display Control Module
DCS	Decompression Sickness
DCSU	Direct Current Switching Unit
DTI	Diffusion Tensor Imaging
EDR	European Drawer Unit
ELDO	European Launch Development Organization
ELIPS	European Life and Physical Sciences
EMU	Extravehicular Mobility Unit
EPFTP	EVA Pre-Familiarization Training Program
EPM	European Physiology Module

ESRC	Economic and Social Research Council
ETC	European Transport Carrier
EVA	Extravehicular Activity
FPS	Fan Pump Separator
FSL	Fluid Science Laboratory
GCR	Galactic Cosmic Radiation
GNC	Guidance Navigation and Control
HPA	Hypothalamic Pituitary Adrenal
HST	Hubble Space Telescope
HUT	Hard Upper Torso
ICC-VLD	Integrated Cargo Carrier-Vertical Light Deployable
ICP	Intracranial Pressure
IDA	International Docking Adapter
IGA	Intergovernmental Agreement
ISLE	In-Suit Light Exercise
ISS	International Space Station
IVA	Intravehicular Activity
JAXA	Japanese Space Agency
JEM	Japanese Experimental Module
KSC	Kennedy Space Center
LCVG	Liquid Cooling Ventilation Garment
LEO	Low Earth Orbit
LET	Launch Escape Tower
LMM	Light Microscopy Module
MAG	Maximum Absorbency Garment
MMOD	Micrometeoroid Orbital Debris
MRI	Magnetic Resonance Imaging
MRM	Mini Research Module
NBL	Neutral Buoyancy Laboratory
NEEMO	NASA Extreme Environments Mission Operations
NOAA	National Oceanic and Atmospheric Administration
NPV	Non-Propulsive Vent
OSTPV	Onboard Short-Term Plan Viewer
PARE	Physiological and Anatomical Rodent Experiment
PLLS	Primary Life Support System
PMA	Pressurized Mating Adapter
RCS	Reaction Control System
SAM	Surface-to-Air Missile
SM	Service Module
SPDM	Special Purpose Dexterous Manipulator
SRB	Solid Rocket Booster
SSAS	Segment-to-Segment Attachment System
SSDS	Surface Supplied Diving System
SSU	Sequential Shunt Unit
STEM	Science, Technology, Engineering and Mathematics

T-RAD	Tile Repair Ablator Dispenser
TCU	Thermal Control Unit
TEPC	Tissue Equivalent Proportional Counter
TPS	Thermal Protection System
TVIS	Treadmill with Vibration and Isolation Stabilization
UKSA	United Kingdom Space Agency
ULA	United Launch Alliance
VIIP	Visual Impairment Intracranial Pressure
XBASE	Expandable Bigelow Advanced Station Enhancement

List of Tables

Preface

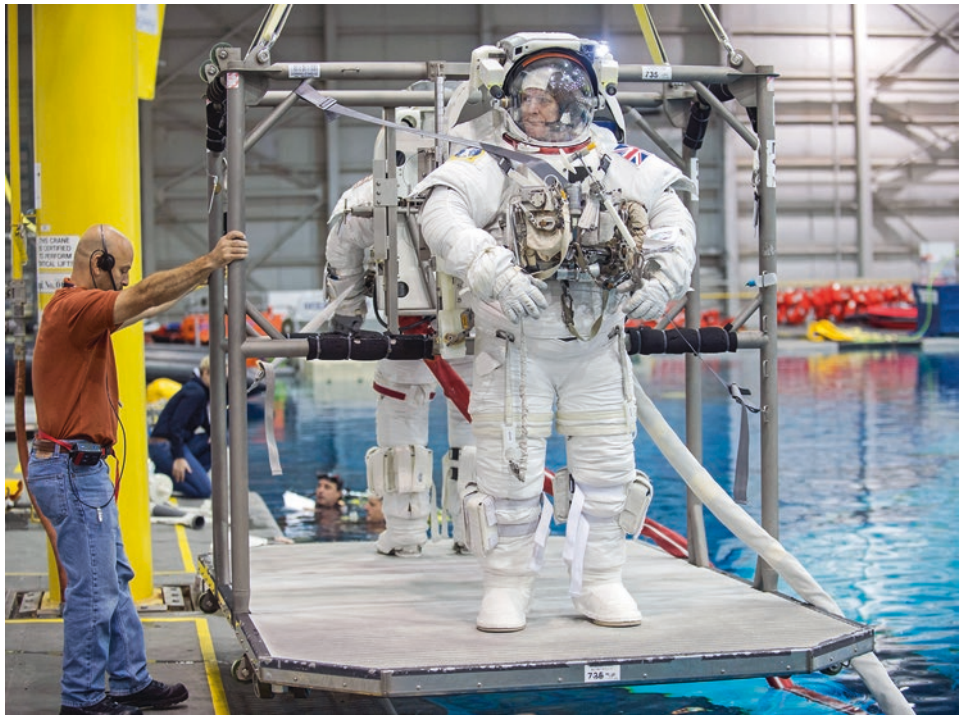
"Tim will continue with his training at the European Space Agency, but if we don't fund any more then he won't get a second flight. We don't lose all the science that we have done, we don't lose the enthusiasm of the young people for science – but where are we in the UK? Just another backward nation that is not participating on the international stage, in the future of the human race? We are a travelling nation; we have explored for centuries and I think it's almost in our blood. It is something that Britain wants to do, Britain needs to do and we have got to continue that funding."

Helen Sharman, on the eve of her 25th anniversary as Britain's first astronaut.

For centuries, the British developed a reputation as a nation of explorers. From Francis Drake's circumnavigation of the globe to the British-sponsored ascent of Mount Everest, British explorers crossed oceans and continents and ventured where few, if any, had gone before. But until very recently, that legacy of exploration had not extended to space. Most other major space-faring nations have shown at least some level of interest in human spaceflight, either by developing their own capability of sending humans into orbit (the U.S., Russia and China), or by piggybacking on those programs (Canada, Japan, and several major European nations). Sadly, the British government (Margaret Thatcher in particular) has had a long-standing opposition to such efforts, declining either to contribute to ESA's human spaceflight efforts or to fund its own. For decades, successive British governments chose to stay out of ESA's human spaceflight program, looking on as more than half a dozen other European countries sent astronauts into Earth orbit. But in 2008, there were signs of optimism for supporters of a UK government-sponsored human space effort when ESA selected a new class of six astronauts. For the first time, the new group included a British representative: Timothy Peake. Then, *finally*, the incumbent coalition government committed £27 million to ESA in 2012 and a further £49 million in 2014. These contributions paved the way for Tim Peake's mission to the International Space Station (ISS). The rest, as they say, is history, and is chronicled in the book you are reading.

> "It's absolutely clear why he got selected against all the odds. They couldn't let him go. He stands out. Most astronauts now are similar, but he is up there in the exceptional class. I think that there was a cowboy element to the original astronauts. Not so with Tim. Tim is ever cool, calm and collected whilst always seeming more charming than macho. When you talk to him, that calmness comes through. It is just about possible to believe that he really enjoyed himself facing the challenge of exercises like escaping from a helicopter cockpit whilst suspended upside down in water. I'd say he is made not so much of the right stuff but rather 'even better stuff'."
>
> *David Southwood, senior researcher at Imperial College, and member of the UK Space Agency steering board.*
> *(*The Guardian*, Ian Sample, December 11, 2015)*

The aim of this book was to put you, the reader, in the flight suit of Britain's first male astronaut. To that end, this book takes you on the journey followed by a British Army officer from Chichester, who spent over 185 days living and working on the ISS, including four hours and 43 minutes of space walks. This book is not organized like the typical biography, which usually follows the chronology of the subject from childhood to the present day. Instead of following a linear timeline, this book uses Tim Peake's experiences to illustrate larger points and themes, such as the stresses of an intensely scrutinized, highly visible job, the challenges of extended family separation, and the ever-present possibility of having to make the ultimate sacrifice: All this against the back-drop of a story-hungry press, starved of any news of British astronauts for the best part of 25 years.



Credit: ESA

> "I think it is really important to reach out to our younger generation and to try to encourage them to take up science, technology, engineering and mathematics as subjects. We have a skills shortage at the moment, and we desperately need more graduates with those backgrounds."
>
> *Tim Peake, speaking with The Mail Online, in an interview with Victoria Woolaston, November 6, 2015.*

Also discussed are the learning curves that have to be met during astronaut and mission training, and the complexity of the technologies required to launch an astronaut into space and keep them alive for months on end. The narrative in the book is written in a way that allows the story and the people to propel the book. The rationale for taking this approach, as opposed to writing subject by subject, is that technology and training, unlike space, does not exist in a vacuum. Complex technical systems, such as the ISS, interact with the variables of human personality, the cultural backgrounds of the astronauts and cosmonauts, and, indeed, the 'culture' which permeates organizations like the British government and ESA.

Credit: ESA

"Obviously, this is the first time a UK Astronaut has flown on board the ISS as part of the European Space Agency, so that's the big thing here. From a government perspective, the UK is becoming involved in human space flight and it is something very important. I hope we go on to continue this involvement. So yes, it is very important the UK is part of this, as there is so much benefit to be had from ISS research in terms of what we are doing on the ISS for people back on Earth. And also on the ISS for future exploration – looking ahead to those lunar and Mars missions, and deeper into the solar system as we go on. I don't want the UK to miss out on that. ESA has been doing a fantastic job, and will continue to do a fantastic job in human spaceflight. I think it is definitely time for the UK to be part of that, and continue to be part of it. It's only going to get bigger and better."

Tim Peake, in an interview with RocketStem's Sam Mundell, February 16, 2015

Credit: ESA

In addition to delving into the life and career of Tim Peake, this book weaves into the narrative the tortured and intransigent political history of manned spaceflight in the UK. Tim Peake's flight was an opportunity that had existed for decades, but was one that had been perpetually almost micro-managed and mismanaged out of existence by successive generations of myopically-minded politicians and bureaucrats. Along the way, the book aims to correct the myriad misunderstandings and warped impressions the British public have about the program: basically, correcting decades of sound-bites made by the sometimes spectacularly misinformed tabloid press. But ultimately, this book is the story of Tim Peake and the Principia mission – and the down-to-the-last-bolt descriptions of life aboard the ISS – by way of the hurdles placed in the path by the British government and the rigors of training at Russia's Star City.

> "The younger generation that I'm talking to as I tour around the UK really will see humans land on Mars for the first time, which is incredibly exciting. We're now looking to set up a habitational module on the Moon as a stepping stone for Mars. I've just been amazed at how well we can live and work in space and still come back to Earth in great shape.

Credit: ESA

"When I've been speaking to my friends on board the ISS now, I do miss it. I miss the view of the Earth and I miss weightlessness – so yes, if the chance came up to start a habitational module on the Moon, I'd be first in the queue."

Tim Peake, talking on Spirit FM, October 18, 2016, on the subject of a second mission and becoming the first Brit to set foot on the Moon.

1

26 million horsepower

Figure 1.0: Credit: ESA

DECEMBER 15, 2015, BAIKONUR COSMODROME, KAZAKHSTAN

The area around the Soyuz rocket is cleared for more than a mile. Clustered in the observation area are family and friends of the crew. Watching a rocket launch from a mile away reduces neck strain and is easier on the hearing when the roar of 26 million horsepower is

E. Seedhouse, *Tim Peake and Britain's Road To Space*, Springer Praxis Books,
DOI 10.1007/978-3-319-57907-8_1

unleashed. But the main – and more sobering – reason for this separation is crowd safety: if the Soyuz *does* explode, the onlookers should be out of harm's way. But that scenario is probably not on the mind of Britain's first astronaut in almost a quarter of a century. This is not because he is oblivious to danger, but simply that he is more accustomed to it than most. After all, that's what test pilots do: they approach risk as something that must be understood, and they do that through a process of training and preparation which is not that dissimilar to astronaut training. So, for all the inherent dangers in the risky business of manned spaceflight, Major Peake's (Figure 1.1) mindset is not focused on a conflagration but rather on the myriad potential problems that may prevent the rocket from launching. Fear? Not likely. This is someone who is as calm and level-headed as they come. An experienced pilot who has flown reconnaissance missions over Northern Ireland and Afghanistan and over the mountains of Bosnia. At night. In winter. Over terrain littered with mines.

> "Tim was one of those guys who stood out in so many ways, even when he was a captain. I wasn't a bit surprised that he was selected. He's modest, he's highly talented, he is a hugely professional aviator and he's a great test pilot. He's the perfect guy to be representing the UK and to be representing the armed forces."
>
> *Richard Folkes, former director of British Army Aviation, who has known Tim Peake for more than a decade.*

Figure 1.1: Tim Peake. Credit: ESA

While fear may not have been uppermost in Major Peake's mind as he prepared for launch, the prospect of 270 tonnes of burning kerosene propelling a 26 million horsepower rocket with him sitting on top of it was probably of concern to his wife Rebecca and their two sons. That anxiety was probably also felt by Major Peake's parents, Angela and Nigel, who waited in the VIP observation area watching the launch timeline scroll down to zero. They were no doubt hoping that all the prelaunch traditions Tim and his colleagues had gone through would pay off in the form of a flawless launch. You see, the Russians are a superstitious bunch when it comes to spaceflight. Not that you can blame them. After all, if you're sitting on top of nearly 300 tonnes of rocket fuel, you probably don't want to push your luck by tripping over any proverbial black cats. Having said that, the Russians tend to take the business of tradition more seriously than most. Consider the signing ritual, for instance. If you're taking a trip to orbit from Russia then you need to make sure you bring a pen, because there are lots of things that must be signed. To begin with, the crew must sign off their spacecraft to approve their vehicle. This may sound strange because none of the crew has had any part in its construction, so it is not clear what the repercussions would be if the crew didn't approve their vehicle. After signing off the Soyuz, the crew must then sign the wall in the Baikonur museum *and* the door of their bedroom (Figure 1.2) before their last night on *terra firma* (when they return, the crew also signs the casing of their capsule).

Figure 1.2: Traditional door signing before launch. It is customary for each crewmember to sign their name on the door of their bedroom after their last night on Earth. Credit: ESA-S. Corvaya.

Another ritual is making sure that you are far removed from the vehicle when it is being rolled out to the pad, because the Russians consider it bad luck for the crew to see their vehicle being rolled out. And on the subject of roll out, as the Soyuz is transported from its hangar by rail, onlookers place coins on the track to be flattened by the train as it inches its way to the pad. This is to bring good luck to the mission and as far as we know, this practice has never led to any derailments, which is probably one reason why this ritual has continued.

As launch day approaches, the rituals come thick and fast. Before the launch, the crew must watch *The White Sun of the Desert*, a 1970 movie that has been watched by *every* crew that has flown from Baikonur. On their way to the pad, the crew must also make a pit stop to relieve themselves, a tradition that goes right back to Yuri Gagarin on his way to the launch of the very first human space flight (he urinated on the rear right tire of the transport bus, for those who need to know the details of this sort of stuff). While this made sense back in the 1960s, given the limitations of spacesuit design in those days, there is no rhyme or reason to the custom today, since the suits are now fitted with diapers. Still, you don't mess with tradition, so today's spacefarers are still expected to unzip and aim their appendage at the right rear wheel. Afterwards, the suit techs do their thing and have to go through the whole rigmarole of zipping the astronauts back in their suits. And if you happen to be a female astronaut? Well, then you bring a sample along with you in a vial and splash it on the wheel.

Signed your name? Check. Watched the film? Check. Urinated on the bus? Check. Great. After he had performed all the necessary pre-ingress rituals, it was time for Peake to clamber on board the 50-meter rocket. Once ensconced in their Soyuz, the crew methodically checked off their pre-flight checklist before attending to yet more pre-flight customs. One of these was to listen to Russian love songs, another tradition started by Gagarin (who else?) who, having checked off all his 'to do' items, requested that Mission Control play some music. The same happened with Peake's flight, although the crew (Figure 1.3) were permitted a selection of their own songs. Peake's selection? *Don't Stop Me Now* (by Queen), *Beautiful Day* (U2), and *A Sky Full of Stars* (Coldplay). Another rite of passage before the crew can get off the ground is to hang a cuddly toy from the instrument panel. This cuddly toy – which the astronauts usually let their kids choose – serves a dual purpose, both as a mascot for the mission, and as a way of indicating to the crew that they have achieved weightlessness. By now you may be wondering if all these traditions aren't a little over the top, but who's to say there isn't something to them. After all, let's not forget that no other country has such an incredible safety record when it comes to the business of sending humans into space: Since 1961 the Russians have lost just 4 cosmonauts during a mission (Soyuz 1 pilot Vladimir Komarov in 1967, and the 3-man Soyuz 11 crew in 1971). The U.S. program, meanwhile, has lost two Shuttle crews (7 per crew in 1986 and 2003) and a SpaceShipTwo pilot. But back to the launch.

> GO for flight! Thanks for all the good luck messages – phenomenal support! #Principia https://t.co/8jbxejHEEe
>
> *Tim Peake's last tweet before launch*

Figure 1.3: Expedition 46 crew (front to back) Tim Peake (ESA), Tim Kopra (NASA), Yuri Malenchenko (Roscosmos). Credit ESA

A volcano of flame erupts from the engines (Figure 1.4). A second later, an ear-splitting roar is heard by the observers in the VIP area. The clock is running on the Principia Expedition. Sheets of ice fall away. Umbilicals are ripped from their tethers. The gantries jerk back and the giant hold-down arms release the Soyuz as it begins to crawl skyward on a plume of flame. Moments later, the fiery rocket is muscling its way through the upper reaches of the atmosphere. Inside the capsule, Peake and his crewmates, their breathing fast and shallow, perform anti-G straining maneuvers as they are pummeled by Gs. The instrument panels scroll the numbers, the velocity accelerating at an incredible rate. In the VIP area, Peake's family and friends look skyward at the rocket, trailing thick smoke, as it arcs eastwards towards the horizon. The sound is still deafening, even with the rocket dozens of kilometers downrange. Inside the Soyuz, the crew continue to be buffeted as the engines adjust the trajectory to give chase to the International Space Station (ISS) which, at their current speed of more than 28,000 kilometers per hour, is just six hours away. Soon, very soon, the only evidence to be seen of a rocket launch is a smoky white contrail curling softly away against the blue sky.

Figure 1.4: Launch of the first Brit in space for 25 years. In among the smoke and flames is a 50-meter-high launcher consisting of three sections. The launcher delivers 26 million horsepower to reach an orbital speed of 28,800 km/h. Within ten seconds of rising from the pad, the three men inside will have travelled over 1,640 km and they will reach the International Space Station in six hours. Helping them to travel at these dizzying speeds are 300 tonnes of propellant; a mixture of kerosene and liquid oxygen generates the propulsion. Credit ESA