

SURVIVAL AND SACRIFICE IN MARS EXPLORATION

What We Know
From Polar Expeditions



ERIK SEEDHOUSE

Survival and Sacrifice in Mars Exploration

What We Know from Polar Expeditions

Other Springer-Praxis books of related interest by Erik Seedhouse

Tourists in Space: A Practical Guide

2008

ISBN: 978-0-387-74643-2

Lunar Outpost: The Challenges of Establishing a Human Settlement on the Moon

2008

ISBN: 978-0-387-09746-6

Martian Outpost: The Challenges of Establishing a Human Settlement on Mars

2009

ISBN: 978-0-387-98190-1

The New Space Race: China vs. the United States

2009

ISBN: 978-1-4419-0879-7

Prepare for Launch: The Astronaut Training Process

2010

ISBN: 978-1-4419-1349-4

Ocean Outpost: The Future of Humans Living Underwater

2010

ISBN: 978-1-4419-6356-7

Trailblazing Medicine: Sustaining Explorers During Interplanetary Missions

2011

ISBN: 978-1-4419-7828-8

Interplanetary Outpost: The Human and Technological Challenges of Exploring the Outer Planets

2012

ISBN: 978-1-4419-9747-0

Astronauts for Hire: The Emergence of a Commercial Astronaut Corps

2012

ISBN: 978-1-4614-0519-1

Pulling G: Human Responses to High and Low Gravity

2013

ISBN: 978-1-4614-3029-2

SpaceX: Making Commercial Spaceflight a Reality

2013

ISBN: 978-1-4614-5513-4

Suborbital: Industry at the Edge of Space

2014

ISBN: 978-3-319-03484-3

Tourists in Space: A Practical Guide, Second Edition

2014

ISBN: 978-3-319-05037-9

Virgin Galactic: The First Ten Years

2015

ISBN: 978-3-319-09261-4

Erik Seedhouse

Survival and Sacrifice in Mars Exploration

What We Know from Polar Expeditions



Springer

Published in association with

Praxis Publishing

Chichester, UK



Erik Seedhouse
Astronaut Instructor
Suborbital Training
Sandefjord, Norway

SPRINGER-PRAXIS BOOKS IN SPACE EXPLORATION

Springer Praxis Books
ISBN 978-3-319-12447-6 ISBN 978-3-319-12448-3 (eBook)
DOI 10.1007/978-3-319-12448-3

Library of Congress Control Number: 2015932248

Springer Cham Heidelberg New York Dordrecht London
© Springer International Publishing Switzerland 2015

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed. The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made.

Cover design: Jim Wilkie
Project copy editor: Christine Cressy

Printed on acid-free paper

Springer International Publishing AG Switzerland is part of Springer Science+Business Media (www.springer.com)

Contents

Acknowledgments	ix
Dedication	xi
About the Author	xiii
Acronyms	xv
Foreword	xvii
1 Exploration Mission Planning	1
Amundsen, the Master Planner	2
Scott’s Misadventure.....	4
Pioneer Your Own Path.....	7
Alternate Path for Mars Trips	7
Stairway to Mars	7
Mars One.....	10
Focus on One Goal at a Time.....	11
Work Smarter, Not Harder	11
Failing to Prepare is Preparing to Fail	13
Go Fast	15
Sponsorship.....	17
Sponsoring a Mars Mission	18
Inspiration Mars	18
Mars One.....	20
References.....	21
2 Expedition Leadership	23
Shackleton’s Transantarctica Expedition	24
Preparation	24
Voyage.....	25
Trapped	25
Abandon ship	26

vi Contents

Elephant Island.....	26
The epic voyage of <i>James Caird</i>	28
South Georgia	30
Traverse of South Georgia	31
Shackleton’s Lessons for Mars Mission Commanders	33
Greely.....	34
Lady Franklin Bay	35
Cape Sabine	36
Rescue.....	36
Greely’s lessons for Mars mission commanders.....	36
Mars Expedition Commander	38
References.....	40
3 Crew Selection and Medical Care	41
Crew Selection	42
The Voyage of <i>Karluk</i>	42
Shackleton’s Way of Selecting a Crew	44
Shackleton’s selection process.....	44
Shackleton’s 10 Guidelines for Choosing Crewmembers.....	47
Male Versus Female Versus Mixed Crew	47
All-women crew.....	47
Mixed crews.....	51
The Antarctic experience	51
All-male crew.....	52
Astronauts with the Wrong Stuff	52
Prophylactic Surgery.....	54
Rogozov’s auto-appendectomy	54
Prophylactic surgery for Mars crews	56
Risk of acute appendicitis	56
Risk of cholecystitis	57
Treatment of appendicitis and cholecystitis	58
Prevention of appendicitis and cholecystitis	59
Risks of organ removal	59
Ethics.....	59
Genetics.....	61
Customizing astronauts.....	63
The Greenland Husky Solution.....	65
References.....	66
4 Isolation and Medical Care	69
Isolation.....	71
Confinement.....	72
Mars500	76
Environment.....	78
Situational Issues	82

Social characteristics.....	82
Polar Madness – cabin fever.....	83
Boredom.....	84
Salutogenesis.....	85
Is There a Doctor On Board? Extraterrestrial Medical Care.....	87
The physiology and pathophysiology of injury in space: A primer.....	90
Damage control.....	91
Initial resuscitation of traumatic injury in space.....	91
Hemorrhage control in space.....	91
Truncal hemorrhage.....	92
References.....	95
5 Getting There and Back.....	97
Choosing a Landing Site.....	98
Polar Landing Site Advantages.....	101
Polar Landing Site Mission Design.....	102
Polar Landing Site Disadvantages.....	103
Ship Design.....	103
The <i>Karluk</i>	104
The <i>Jeanette</i>	105
The <i>Endurance</i>	105
Entry, Descent, and Landing.....	106
References.....	109
6 Surviving.....	111
Stewed Penguin, Hoosh, and the Power of Pemmican.....	112
Survival Rations.....	115
Red Planet Cafe.....	116
Eating in the Red Planet Cafe.....	118
Weather.....	118
What Polar Survival Can Teach Astronauts about Surviving on Mars.....	119
Mars: no place to be caught in a storm.....	119
Douglas Mawson.....	121
Mawson’s survival.....	121
Valerian Albanov.....	124
What If an Astronaut Had to Survive on Mars?.....	126
Simulating Mars.....	130
Two Years Under the Glass.....	133
References.....	134
7 Sacrifice.....	135
Captain Oates.....	136
For the Common Good.....	138
Cannibalism.....	139
The Greely Expedition.....	142

viii **Contents**

Cannibals on Mars	143
No Bodies on Board!	145
Cryomation	146
References.....	146
8 Inbound	147
Mutiny.....	148
On the Edge in Space.....	148
Apollo 7	148
Skylab 4	149
Mir.....	150
ISS.....	151
Mars Mission Mania and Mutiny.....	153
The Price of a Ticket to Mars: Rehab	154
Bone density.....	156
Muscles	156
Blood pressure	156
Eyesight.....	156
Astronaut Strength Conditioning and Rehabilitation.....	159
Epilogue	161
References.....	161
Index	163

Acknowledgments

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, to Clive Horwood and his team at Praxis for guiding this book through the publication process and to D. Raja and Rekha Udaiyar for their meticulous attention in bringing this book to publication. The author also expresses his deep appreciation to Christine Cressy, whose attention to detail and patience greatly facilitated the publication of this book, and to Jim Wilkie for creating yet another striking cover.

*To those select few who boldly follow
in the footsteps of Amundsen, Mawson,
Shackleton, and Nansen*

About the Author

Erik Seedhouse is a Norwegian suborbital astronaut whose life-long ambition is to work in space. After completing a degree in Sports Science, the author joined the 2nd Battalion the Parachute Regiment. During his time in the “Para’s”, 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 C130, performed more than 200 helicopter abseils, and fired more anti-tank weapons than he cares to remember!

Upon returning to the comparatively mundane world of academia, the author embarked upon a master’s degree in Medical Science, supporting his studies by winning prize money in 100-km running races. After placing third in the World 100 km Championships, the author 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 and the Decatriathlon, an event requiring competitors to swim 38 km, cycle 1,800 km, and run 422 km. Non-stop!

Returning to academia, Erik pursued his Ph.D. at the German Space Agency’s Institute for Space Medicine. While studying, he won Ultraman Hawaii and the European Ultraman Championships, and completed Race Across America. As the world’s leading ultra-distance triathlete, Erik was featured in dozens of magazines and television interviews. In 1997, *GQ* magazine nominated him as the “Fittest Man in the World”.

In 1999, Erik retired from triathlon and started post-doctoral studies. In 2005, he worked as an astronaut training consultant for Bigelow Aerospace and wrote *Tourists in Space*. He is a Fellow of the British Interplanetary Society and a member of the Space Medical Association. In 2009, he was one of the final 30 candidates in the Canadian Space Agency’s Astronaut Recruitment Campaign. Erik works as a spaceflight instructor for the American Astronautics Institute, professional speaker, triathlon coach, author, and Editor-in-Chief for the *Handbook of Life Support Systems for Spacecraft*. He is the Training Director for Astronauts for Hire and, between 2008 and 2013, he served as director of Canada’s manned centrifuge operations.

In addition to being a suborbital astronaut, triathlete, centrifuge operator, pilot, and author, Erik is an avid mountaineer and is pursuing his goal of climbing the Seven Summits.

Survival and Sacrifice is his seventeenth book. When not writing, he spends as much time as possible in Kona on the Big Island of Hawaii and at his real home in Sandefjord, Norway. Erik and his wife, Doina, are owned by three rambunctious cats – Jasper, Mini-Mach, and Lava.



Inside the Fram Museum, Bygdøy, October 2014, Credit: Adrian Seedhouse

Acronyms

AAE	Australasian Antarctic Expedition
AFT	Advanced Food Technology
ASCR	Astronaut Strength and Conditioning Rehabilitation
ATLS	Advanced Trauma Life Support
ATS	Adaptability Training System
BAE	British Antarctic Expedition
BMD	Bone Mineral Density
CHeCS	Crew Health Care System
CSA	Canadian Space Agency
CSM	Command Service Module
CT	Computed Tomography
DC	Damage Control
EDL	Entry, Descent, and Landing
FMARS	Flashline Mars Arctic Research Station
GCR	Galactic Cosmic Rays
HI-SEAS	Hawaii Space Exploration Analog and Simulation
ICE	Isolation, Confinement, Environment
IHMC	Institute for Human and Machine Cognition
ISRU	In-Situ Resource Utilization
ISS	International Space Station
LEM	Lunar Excursion Module
MIS	Minimally Invasive Surgery
MRE	Meals Ready to Eat
MRI	Magnetic Resonance Imaging
NAA	North American Aviation
POMS	Profile of Mood States
SA	Suspended Animation
SDSC	Space Development Steering Committee
SEI	Space Exploration Initiative

xvi **Acronyms**

SLS	Space Launch System
SPE	Solar Particle Event
SSME	Space Shuttle Main Engine
STP	Supersonic Transition Problem
VASIMR	Variable Specific Impulse Magnetoplasma Rocket

Foreword

Much has been written about manned missions to Mars. Intuition and experience during long-duration spaceflight tell us the experience of such a mission will be so different from life on Earth that unearthly changes will manifest themselves in the crew, hence the need for extensive research. We know there will be dramatic physiological changes during such a mission and therefore believe there must be comparable psychological changes. We search for answers in analogs of the space environment, stuffing crewmembers inside hermetically sealed cans for months at a time, and see in these analogs only examples of human frailty. We read that the incidence of psychiatric cases in Fleet Ballistic Missiles submarines is 4/1,000, conveniently overlooking the fact that the rate of reported psychiatric illness is lower in submarines than in the surface fleet.



F.1 Credit: Mars Society

The history of polar exploration provides us with myriad examples of how explorers have performed admirably under appalling and testing circumstances. The crew of Fridtjof Nansen's *Fram* left home on 24 June 1893 and did not return for more than three years. More than two years of that absence was spent frozen in the polar ice with no outside contact. No Wi-Fi or Facebook for these guys, yet they survived an ordeal that was far, *far* more arduous than a mission to Mars, and did so in (mostly) good spirits.

Men wanted for hazardous journey. Small wages. Bitter cold. Long months of complete darkness. Constant danger. Safe return doubtful. Honour and recognition in case of success.

Job description from Ernest Shackleton, recruiting for his 1915 Imperial Transantarctic Expedition¹

Another example of an arduous expedition was Shackleton's Imperial Transantarctic Expedition, an epic journey that took as long as a manned Mars mission is envisaged to take using chemical propulsion. Given the brutally honest nature of the ad, it is perhaps surprising anyone

¹ This advertisement is perhaps one of the most famous in history, but its origins are very obscure because no one has actually seen the ad printed in a newspaper: the Antarctic Circle has a US\$100 reward out for anyone who can find it, but the reward has yet to be claimed. The ad was supposed to have appeared in the *London Times* on 29 December 1913.