THE ATLAS OF SPACE ROCKET LAUNCH SITES

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DOM
publishers

CONTENTS

4 INDO-AFRICAN

5 ASIA-PACIFIC

Paul Meuser

SPACE TRAVEL STARTS ON EARTH

The machines that orbit our planet live in a void environment – however, space travel itself does not exist in a vacuum. Travelling to space is an immense effort of humans and machines, taking not just 'one small step for man' but leaving behind a huge carbon footprint in the process. We are in the midst of a paradigm shift in which private companies and leadership figures in the form of billionaires are re-popularising space travel to an extent not seen since the space race between the USSR and USA. When thinking about space travel today, two types of images come to mind: renderings of pristine machines backlit by the blue of Earth or a large plume of smoke created by the thundering engines of a rocket leaving its launch pad. Both show in a literal sense the inherent unearthliness of space travel. Space exists isolated from the place that births its mechanical and few select human inhabitants. Thus, we tend to forget that every single thing that exits our atmosphere takes with it more than just its own weight of materials when it departs our fragile blue marble.

Beginning with the day our ancestors first began to consciously observe the starry night sky, our perspective has not always been an outlooking one. Throughout many cultures that mastered the science of astrology, they were able to use the stars as a calendar for rituals and agricultural seasons. This fascination has left its artefacts across the planet in the form of objects, carvings, and architecture. However, for these cultures, the cosmos might have always been in plain view but out of reach. Today, illuminated by our cities' blaring lights, the stars have become bleached from our nights, and we rely for the most part on digital images of distant galaxies shot on orbiting telescopes. Within the discourse of sustainability, we might not only want to return to a life connected to nature, but also begin to re-ground our perspective on both the cosmos and its new artifacts.

According to the UN's 'Scientific Assessment of Ozone Depletion' in 2018, the total effects of exhausts produced during launches account for less than 0.1 per cent of humans' effect on the atmospheric layer. However, this paints a far too narrow picture of the real consequences we are facing with an exponential increase in space travel. As a three-dimensional discipline, it is vital to acknowledge that space exploration's effects do not simply apply to Earth's enamel: its effects continue into space itself and span the globe through political, sociological, and economical factors far beyond the scope of environmental chemistry.

In the past 200 years we have seen a shift from nationalised economies to an increasing privatisation of our earthly society. This economic shift has now found itself being launched into space on million-dollar machines – into a space that has been declared public for humanity as a whole by all nations. Thus, our cosmos has to be of public concern more than ever, as it is an extension of our earthly environment that belongs to all of humanity. Today's space is a site of resource extraction in the form of digital infrastructure for the ultra-wealthy. While Earth-orbit's first inhabitant Yuri Gagarin flew to space with the sole purpose of projecting technological superiority to the Soviet Union's ideological counterpart and as a human guinea pig, proving that humans can survive such a trip, we are still in search of answers to the question of our purpose in space. When watching Jeff Bezos and Richard Branson float by their capsule windows, we are reminded that only a handful of people are behind the steering wheel of cosmic colonisation. A glimpse into the future might lie within an inconspicuous container arriving in Ukraine. Opening it reveals a wall of cardboard boxes containing the newest Starlink internet system, courtesy of SpaceX. While Europe regresses into the brutality of war, an American billionaire commands a satellite array to stream free internet to the proud new owners of the company's prototype receivers. As of June 2022, around 15,000 Starlink 'kits' have been delivered to Ukraine, offering another dimension in the modern war of information. With the rise of the private space sector, we have witnessed a new age of space exploration allowing for a rate of progress not seen before. As a new consumer market, the question of when space travel will become a part of our daily lives is no longer a question of how but a matter of when. To a great extent it already is, and it already raises fundamental questions about our own morals and efficacies. To reason about the ethics of space

Map of launch sites worldwide

1 THE AMERICAS 34

2 BALTO-MEDITERRANEAN 88

3 EURASIA 116

4 INDO-AFRICAN 156

5 ASIA-PACIFIC 184


Plesetsk
3
Kapustin Yar
Baikonur
Caspian Sea
Semnan
Persian Gulf
Red Sea
Vostochny
Jiuquan
Taiyuan
Sohae
East Sea
Naro
Uchinoura
Tanegashima
Xichang
Wenchang
Pacific
Ocean
Southeast Asia Sea
Sriharikota
Thumba
Kulasekharapatnam
4
Equator
5
San Marco
Indian
Ocean
Woomera
Great Australian Bight
Mahia

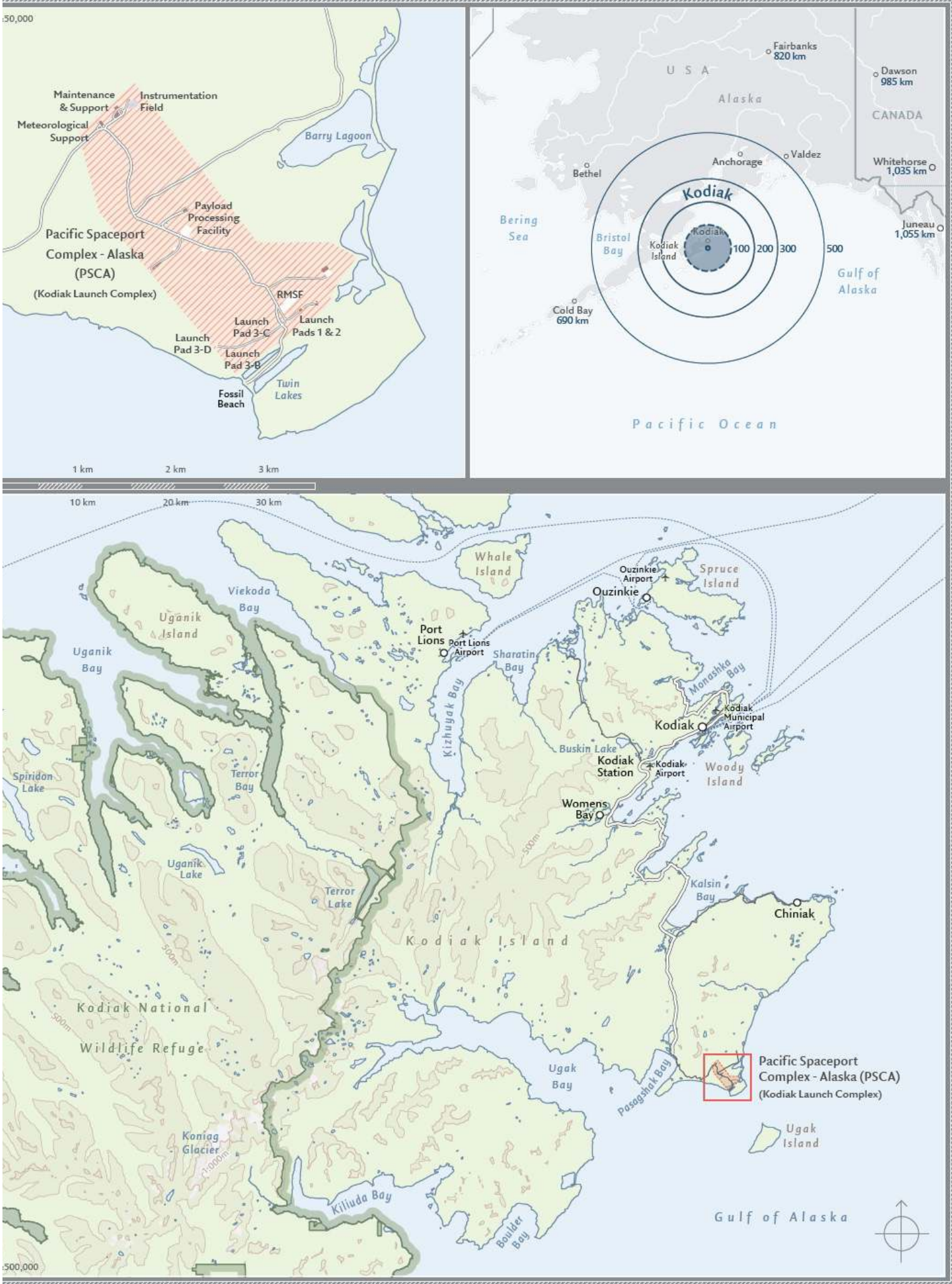
Brian Harvey

AN INTRODUCTION TO THE HISTORY OF LAUNCH SITES

The first rocket pioneers did not have the gleaming high-tech launch bases we know today. Sergei Korolev and his colleagues headed out into the forests around Moscow and let off their small rockets in clearings, hoping that they would at least clear the treetops. Robert Goddard fired his small rockets from a farm, now a golf course, in Auburn, Massachusetts. Wernher von Braun and his colleagues made a *Raketenflugplatz* ('rocket flight place') in Berlin itself until he was taken on by the German Army and the test grounds moved out of Berlin to the gently rolling fields and woods near Kummersdorf. Hideo Itokawa used a beach in Japan and Vikram Sarabhai operated from a beachside church – with the congregation's permission. Nowadays, a plaque may mark these places but there is not much evidence now of what took place nearly one hundred years ago. They fired quite small rockets – Itokawa's were so small they were called 'pencils'.

The first real, modern rocket was Von Braun's A-4 or V-2, which weighed over 20 tonnes, used a high-performance engine, and reached the edge of space. It required a concrete launch platform called a *Prüfstand* ('test stand'), fuelling facilities, and systems for supervision and tracking – what we would now call mission control. Homes were constructed to house the launch site workers. Thus was created the first modern launch base: Peenemünde on the Baltic Sea. Peenemünde had many of the defining characteristics of most of the world's subsequent launch sites. Being on the Baltic, the land was flat, making rail and road transport easier. It was beside the sea, so that rockets would quickly be over the sea where, if things went wrong, they would crash there rather than fall on people's homes. From the military point of view, it was distant from prying photo reconnaissance planes, though in practice distance never stopped inquisitive aircraft from discovering launch sites, as other countries were to find out later. Peenemünde was the first, but far from the last, of the 'secret' launch sites and many came to be surrounded in mystery and intrigue, their locations concealed, and their existence even denied. Seaside or coastal launch sites became the norm for the United States (Cape Canaveral, Vandenberg, Wallops Island), Japan (Tanegashima, Uchinoura Kagoshima), India (Sriharikota), Europe (Kourou), and China (Wenchang).

The A-4 was the basis of post-war rocketry, with the Allies descending on Germany to scour the country for its remains. They were able to scavenge enough A-4s and parts to launch their own. With a limited run of firings, the immediate post-war sites were minimalist, comprising a concrete pad and some tracking systems. The British fired A-4s over the North Sea from Cuxhaven; the Americans went to the deserts of White Sands, New Mexico; the British moved to Woomera, Australia; and the Soviet Union went to the flatlands east of the Volga River at Kapustin Yar. This introduced the second type of launch site: the desert. Although there was still the danger that rockets could go off course toward a populated area – one A-4 famously crashed near El Paso – most rockets or their stages were likely to fall over relatively unpopulated areas, though not always with much regard for the small numbers of people who did live there. Deserts were more challenging for communications, but being far inland, had the advantage of being even further away from observation by other countries. The desert launch base was to be the norm for the Soviet Union (Kapustin Yar), France (Hammaguir, Algeria), China (Jiuquan), Iran (Semnan), and Britain (Woomera, Australia).


50,000
Maintenance & Support
Instrumentation Field
Meteorological Support
Barry Lagoon
Payload Processing Facility
Pacific Spaceport Complex - Alaska (PSCA)
(Kodiak Launch Complex)
RMSF
Launch Pad 3-C
Launch Pads 1 & 2
Launch Pad 3-D
Launch Pad 3-B
Fossil Beach
Twin Lakes
1 km
2 km
3 km
U S A
Alaska
CANADA
Fairbanks
820 km
Dawson
985 km
Anchorage
Valdez
Bethel
Whitehorse
1,035 km
Kodiak
Bering Sea
Bristol Bay
Kodiak Island
100
200
300
500
Juneau
1,055 km
Gulf of Alaska
Cold Bay
690 km
Pacific Ocean
10 km
20 km
30 km
Whale Island
Ouzinkie Airport
Ouzinkie
Spruce Island
Viekoda Bay
Uganik Island
Uganik Bay
Port Lions
Port Lions Airport
Sharatin Bay
Kizhuyak Bay
Monashka Bay
Kodiak Municipal Airport
Kodiak
Buskin Lake
Kodiak Station
Kodiak Airport
Woody Island
Spiridon Lake
Terror Bay
Womens Bay
500m
Uganik Lake
Terror Lake
Kalsin Bay
Chiniak
Kodiak Island
Kodiak National Wildlife Refuge
Ugak Bay
Pasagshak Bay
Pacific Spaceport Complex - Alaska (PSCA)
(Kodiak Launch Complex)
Ugak Island
Koniag Glacier
1,000m
Killiuda Bay
Boulder Bay
Gulf of Alaska
500,000

Plesetsk, Russia

BUSIEST COSMODROME IN THE WORLD

Name
Plesetsk Cosmodrome

Location
Plesetsk, Russia

Owner / Operator
Russian Ministry of Defence

Elevation
85 m

Coordinates
40.5°N, 62.8°N

Time zone
GMT+6

Launches
2,156 satellites

Completion
1966

Given that more rockets have been launched from here than anywhere else, Plesetsk is surprisingly little known. Although Baikonur (qv) was and is Russia's primary cosmodrome, Plesetsk was the busiest and by 2000 had accounted for 38 per cent of all the world's launches.

The reason lies in its military origins and because it has since been used principally for military launches, though important scientific missions have also taken place from here. Plesetsk was not visited by non-Russians until the arrival of visitors from the socialist countries at the end of the Soviet period, with western Europeans following afterwards. Unlike Baikonur and Vostochny (qv) cosmodromes, which are civilian, Plesetsk remains under military control: launch workers are military staff and turn out in drill formation for inspection when rockets are being prepared. Plesetsk is in a forest area in the far north at 63°N, just short of the Arctic Circle (66°N) and 200 km south of Archangel. It is bitterly cold in winter and dark almost all day, while summers are warm with a short twilight and no real darkness. Temperatures are even more extreme than Baikonur, dropping as low as -46°C and routinely hovering around -20°C in midwinter, though this has never affected launches. It is the cosmodrome closest to western borders: space enthusiasts in Finland and Sweden have even seen the red and yellow glow of rockets rising into the distant night sky to the east.

Plesetsk started life as a military base for the Soviet Union's Intercontinental Ballistic Missile (ICBM) strike force. On 11 January 1957, General Secretary Nikita Khrushchev signed the order for the construction of the cosmodrome. The area comprised a mixture of dense forest, swamp, ravines, and rocky outcrops.


ISRO
INDIA
ISRO
INDIA


10 million
USA
MEXICO
Pacific
Ocean
Caracas
ALGERIA
Abuja
Stage 1 & 2
powered flight
Block DM-SL burn
Quito
SC Separation
Equator
1st Apogee Passage
PERU
Lima
BRAZIL
Brasilia
Atlantic
Ocean
Luanda


Oslo
Reykjavik
Helsinki
Moscow
Greenland
Arctic
Ocean
Hudson
Bay
Ottawa
Washington
Nur-Sultan
Bishkek
RUSSIA
CANADA
MONGOLIA
Rocky Mountains
USA
New Delhi
Ulaanbaatar
Kathmandu
Thimphu
Bering
Sea
MEXICO
Beijing
Dhaka
Los Angeles
Mexico City
Vladivostok
CHINA
Pyongyang
Seoul
180°
Hanoi
Vientiane
JAPAN
Tokyo
Bangkok
Taipei
Phnom Penh
Northern
Pacific Ocean
Mariana Trench
Kuala
Lumpur
Manila
Singapore
Hawaii
Bandar
Seri Begawan
Jakarta
Melekeok
Equator
International Date Line
INDONESIA
154° W
Dili
SOLOMON
ISLANDS
Port Moresby
Honiara
Southern
Pacific Ocean
AUSTRALIA
VANUATU
Port Vila
Suva
FIJI
Canberra
Wellington

Cover illustration by John Berkey, which appeared in the magazine *Popular Mechanics*.
Source: Popular Mechanics 8/1999

hydraulically to the vertical, Odyssey was evacuated, and the launch was entirely automated and monitored from Sea Commander. Sea Launch made a perfect demonstration mission in March 1999, with its first operational mission coming that October. By 2014, Sea Launch had made 36 launches for American, European, and Asian customers (with three failures). The project then halted when Zenit production stopped. Sea Launch was bought for $150m by the Russian S7 Airlines in April 2018. After lengthy negotiations for their departure from Long Beach, both vessels crossed the Pacific in 2020 to reach Slavyanka, Primorsky, at the southernmost tip of the Russian far east, for outfitting with the new Soyuz 7 rocket. In poor, stripped out condition, restoration would take some time.

Next double page:
An aerial view of Hong Kong's Xin Guang Hua heavy load carrier carrying the Odyssey mobile maritime spacecraft launch platform of the Sea Launch international spacecraft launch service that arrived from the United States at Slavyanka Port.
Source: Picture Alliance / Dmitry Yefremov / TASS

Blue Origin: Jacklyn

SpaceX: Drone ship

NASA: Sea Dragon (concept)

NASA: Saturn V

BIOGRAPHIES

Author

Brian Harvey is a writer and broadcaster on spaceflight who lives in Dublin, Ireland. He has a degree in history and political science from the University of Dublin (Trinity College) and an MA from University College Dublin. His first book was *Race into Space – The Soviet Space Programme* (Ellis Horwood, 1988), followed by further publications on the Russian, Chinese, European, Indian, and Japanese space programmes. His books and book chapters have been translated into Russian, Chinese, and Korean. He has recently completed *China in Space – The Great Leap Forward* (2nd, edition, Praxis-Springers, 2019), now being translated into Chinese for publication there, and *European-Russian Space Cooperation – From De Gaulle to ExoMars* (Praxis-Springer, 2021). He has broadcast on BBC, Canadian Broadcasting Corporation (CBC), Voice of America, and China Television (*Dialogue - ideas matter*). He has contributed to films by CBC (Mir), Danish television (closed ecological systems), and Australian television (the H-II Japanese rocket), subsequently shown on the Discovery channel. He has been interviewed for *The Observer, Christian Science Monitor, The Guardian, Наша Газета (Nasha Gazeta) Le Scienze, Ça M'intéresse,* and *The Hindu*. He has written articles on spaceflight from the 1970s in magazines such as *Orbit, Astronomy and Space, Go Taikonauts!,* and *Spaceflight*, and for newspapers such as the *Sunday Press* and the *Irish Independent*. His articles have been published in *Astronomy Now, Space Quarterly, Space Policy, Journal of the British Interplanetary Society, Zenit, Quest,* and by the Leibniz Society in Berlin. He is a Fellow of the British Interplanetary Society (FBIS) and co-chaired its annual Sino-Russian forum for a number of years. He contributed to the review of space policy by the Department of Business and Skills that led to the establishment of the UK Space Agency (UKSA). Marking the 50th anniversary of manned spaceflight, he opened the UK Yuri Gagarin exhibition in Edinburgh, organised by the Princess Dashkova Centre of the University of Edinburgh.

Co-Author

Gurbir Singh is a UK-based non-fiction writer specialising in space. He studied science and computing and holds a science and an arts degree. Once keen on aviation, he has a private pilot's licence for the UK, USA, and Australia. He was one of 13,000 unsuccessful applicants responding to the 1989 advert '*Astronaut wanted. No experience necessary*' to become the first British astronaut. Helen Sharman was eventually selected and flew on the Soviet space station Mir in 1991. He has written articles for *The Space Review, Go Taikonauts!, Journal of the British Interplanetary Society,* and *Spaceflight* and has been interviewed for BBC Manchester, Deutsche Welle, and the BBC World Service. In late 2018, he stopped working full time as a cyber security consultant to spend more time on his writing. He is also the publisher of the website www.astrotalkuk.org, a not-for-profit astronomy podcast established in 2008. In 2011, he published his first book, *Yuri Gagarin in London and Manchester.* The book traces the visit of the world's first spaceman's five days in England, with first-hand accounts from the people who saw and met him. His second book, *The Indian Space Programme,* published in October 2017, is a detailed account of the origin of India's space programme, its achievements, and future ambitions. His third book, *India's Forgotten Rocket Pioneer,* is a biographic account of the life and work of Stephen H. Smith, who experimented with rockets between the 1930s and 1940 in Calcutta, India.

Editor

Paul Meuser is a researcher and artist dealing with both the interstellar ambitions and earthly artifacts of humanities leap into space. Born in 1996 in Berlin, Germany, he holds a BFA with a concentration in 'computation, technology, and culture' from the Rhode Island School of Design, and an MArch from the Yale School of Architecture. In 2019, he published the *Architectural Guide Moon*, exploring the first permanent human footprints on our grey neighbour (German edition: 2019/DOM publishers; Lithuanian edition: 2022/LAPAS publishing house; Russian edition: in progress). Together with the Yale Centre for Collaborative Arts and Media and the Massachusetts Institute of Technology (MIT), he took part in an experimental ZeroG flight with scientists and artists. Experiencing the absence of gravity on oneself was truly eye-opening, connecting research and the experience itself. His earthly work focuses on robotics and its applications beyond their conventional uses. His most recent explorations dealt with the use of soft robotics to introduce age and mortality into machines and satellites. He currently works as an architect and design engineer in Tunisia.

Maps

Katrin Soschinski has been working as a freelance cartographer since 2007, both on a freelance and project basis for publishers, agencies, and planning offices. One focus of her work is textbook cartography, but cartographic support for public sector spatial planning is also part of her spectrum. She concentrates mainly on the print sector. After studying geography and cartography in Bochum and completing a cartographic publishing traineeship at the Bertelsmann subsidiary *wissenmedia* in Stuttgart, she lived and worked in Berlin for 10 years. At the end of 2019, she moved to the western Ruhr region, where the focus of her life has been ever since. Her cartography is influenced by her interest in design and art, while at the same time shaped by the hope for a free, safe, and healthy world in the future.