JAPANESE MISSIONS to the INTERNATIONAL SPACE STATION

Hope from the East

John O'Sullivan

Springer

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Foreword

"Kibō" is the name of the Japanese Experimental Module attached to the International Space Station (ISS), and the word means "Hope" in Japanese. The Kibō project began in the 1980s, and I myself was involved in its system integration as an engineer at Japan Aerospace Exploration Agency (JAXA) in the late 1990s prior to being selected as an astronaut candidate. I therefore witnessed the hard work by so many dedicated people during the development.

I still vividly remember the figure of Kibō in a clean room during the process of its production. Approximately 2.5 million components from over 600 companies, including computers, wiring, and ducts, were being integrated into the structure. The two windows on the side resembled human eyes, the airlock looked like a human mouth, and the robotic arm appeared like a real arm. It was as if the engineers were putting a soul into it and creating an artificial cyborg.

In 2010, I visited Kibō in space. It was a very impressive reencounter for me. Kibō not only embodies the hopes of Japanese space development; it is also a symbol of the international collaboration that created the ISS. During the mission on board the ISS, I, along with an American crewmate, manipulated the Canadian robotic arm and attached the Italian-built logistic module "Leonardo" onto the ISS. After it was berthed, all of the crew members, including Russian colleagues, installed various equipment which it had delivered. At that time, I strongly felt the bond of international collaboration.

Naoko Yamazaki (JAXA)

I would like to express my sincere appreciation to all the people who have dedicated their working lives to the individual national space programs involved, the families that supported them, and the people who encouraged them. The spirit of “Kibō” will inspire the next generation of space explorers.

Naoko Yamazaki
JAXA astronaut

Preface

After writing my first book in 2016, *In the Footsteps of Columbus, European Missions to the International Space Station*, I was eager to push on and create a series of books that highlight the often forgotten contributions of Europe, Japan and Canada as the smaller partners in the International Space Station (ISS).

This book narrates the Japanese missions to the ISS. It is laid out in much the same manner as *Footsteps*, beginning with a brief summary of Japanese human spaceflight prior to the ISS missions, followed by an overview of the various spacecraft referenced in the text and then a detailed description of each mission. The mission chapters include the statistics (dates, times, spacecraft vehicles, personnel) for each mission, a catch-up on the 'story so far' for the ISS, a biography of each astronaut, a look at the mission patches and a day-by-day or weekly log of each mission.

Whilst the Japanese Aerospace Exploration Agency (JAXA) is a relatively young space agency because it was founded in 2003, its antecedents go back to the 1950s. In 2003, three government organisations merged to create JAXA. The Institute of Space and Astronautical Science (ISAS) was primarily responsible for astronomical and planetary science studies. It was founded in 1981 with the amalgamation of university institutes led by the University of Tokyo. The National Aerospace Laboratory of Japan (NAL), which studied aeronautics and rocketry, was founded in 1955 as the National Aeronautical Laboratory. The National Space Development Agency (NASDA), which was founded in 1969, was responsible for satellites, launch vehicles, launch facilities and tracking. NASDA was also the agency responsible for human spaceflight with selection and training of astronauts and their missions in partnership with the US National Aeronautics and Space Administration (NASA), the European Space Agency (ESA) and the Canadian Space Agency (CSA).

In the late 1990s and early 2000s, failures by H-II and M-V launch systems and the failure of the Nozomi Mars mission led to calls for integration and streamlining of the government's space efforts, hence the establishment of JAXA in 2003.

The first chapter outlines the history of Japanese human spaceflight in advance of Koichi Wakata's ISS assembly mission on STS-92. This era includes a privately funded space tourist flying to Russia's Mir space station, Spacelab and Spacehab missions on NASA shuttles, the retrieval and return to Earth of a Japanese microgravity research satellite, the first Japanese spacewalk and the Shuttle Radar Topography Mission which mapped the planet.

The next chapter gives a brief description of the various spacecraft employed by Japanese astronauts to reach space, namely the Space Shuttle and the Soyuz, and the uncrewed vehicles that have resupplied them on board the ISS, namely the Russian Progress, the European ATV, the Japanese HTV, and the American Dragon and Cygnus commercial vessels.

Since STS-92, all Japanese missions to the ISS have involved assembly and supply tasks, particularly of the JAXA Kibō laboratory, and astronauts have conducted long-duration tours. These missions are covered in the following chapters.

As Japanese astronauts do not tend to name their missions in the way that ESA astronauts do—for example Thomas Reiter's 2006 *Astrolab* mission or Paolo Nespoli's 2010 *Magisstra* mission—the names of these chapters reflect the launch vehicle on which the astronauts flew, e.g. STS-92 and the ISS expedition number.

The information for these missions came from a variety of sources, including NASA, ESA and JAXA mission status reports, astronaut biographies and blogs, contemporaneous magazine articles and reference websites such as the encyclopaedic *www.spacefacts.de*. Over the years, the methods and practices of writing and maintaining these logs have evolved. As a result, the level of detail or data recorded may differ between a shuttle mission and an ISS expedition or between a 1990s mission and a twenty-first-century mission. Although I have tried to keep a common format across the chapters, this was not always possible.

For the long-duration expeditions on which astronauts spend up to 6 months in space, some of their duties are less than exciting. Although I have tried to cover all the routine maintenance tasks and medical tests they undertake on the station (e.g. microbial sampling, weekly cleaning housework, acoustic testing, packing and unpacking of cargo, maintaining inventory logs, eating meals, logging food intake, sleeping, pre-sleep and post-sleep reaction time testing, Earth photography, conference calls with ground control, charging batteries, the maintenance of equipment and the daily exercise regime), I *haven't* listed these tasks repetitively; I have instead focused on the highlights of each astronaut's mission.

A rich story of human spaceflight occurred between and around the Japanese missions that are detailed in this book. Although I have mentioned key missions and events in American and Soviet/Russian spaceflight that occurred during this time period, these missions lie outside the scope of this book. I have provided a bibliography for readers wishing to explore this exciting period of space history.

When selecting terminology, I have used the term 'astronaut' when describing flights on American spacecraft and 'cosmonaut' for flights on Soviet or Russian spacecraft. However, the same spacefarer could be described as both over the course of the book because some Japanese have flown on both American and Russian craft.

John O'Sullivan
September 2018

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About the Author

John O'Sullivan BE, BSc (Hons), Dip PM, CEng MIEI, PMP, FSP, CMSE® studied Electrical Engineering at University College Cork. He has over 20 years' experience in the automation and control sector delivering solutions to the life-science industry in Ireland. He is a Chartered Engineer with Engineers Ireland and also a Project Management Professional with the Project Management Institute. He has always had a fascination with aviation and space, leading him to gain his private pilot license in 2003 and study astronomy. He has been awarded a degree in Astronomy and Planetary Science from the Open University, as well as a diploma in Project Management from the Cork Institute of Technology. He was an unsuccessful candidate for the ESA Astronaut Corps in 2008. He lives in East Cork, Ireland. His first book, *In the Footsteps of Columbus, European Missions to the International Space Station*, was published by Springer-Praxis in 2016. This is his second book.

Acronyms

ABC	American Broadcasting Company
AF	Assembly flight
AIS	Automatic Identification System
AM	Membership of the Order of Australia
AMS	Alpha Magnetic Spectrometer
ANA	All Nippon Airways
ANDE	Atmospheric Neutral Density Experiment
AQH	Aquatic Habitat
AQM	Air quality meter
ARB	Acceptance Review Board
ARED	Advanced Resistive Exercise Device
ARISS	Amateur Radio on the ISS
ARS	Air Revitalisation System
ASI	Agenzia Spaziale Italiana (Italian Space Agency)
ASIM	Atmosphere-Space Interactions Monitor
ASTP	Apollo–Soyuz Test Program
ATA	Ammonia Tank Assembly
ATK	Alliant Techsystems
ATV	Automated Transfer Vehicle
BBC	British Broadcasting Corporation
BCC	Backup control centre
BCDU	Berthing Mechanism Control and Display Unit
BCM	Battery charger module
BE	Bachelor of Engineering degree
BEAM	Bigelow Expandable Activity Module
BGA	Beta Gimbal Assembly
BISE	Bodies in the Space Environment

BPSMU	Battery Powered Speaker Microphone Unit
BSc	Bachelor of Science degree
BUC	Backup controller
C2V2	Common Communications for Visiting Vehicles
CapCom	Capsule communicator
CAVES	Cooperative Adventure for Valuing and Exercising human behaviour and performance Skills
CB	Clean bench
CBEF	Cell Biology Experiment Facility
CBEF 1G IU	Cell Biology Experiment Facility 1G Incubator Unit
CBM	Common Berthing Mechanism
CBS	Columbia Broadcasting System
CCAA	Common Cabin Air Assembly
CDR	Commander
CDRA	Carbon Dioxide Removal Assembly
CDT	Central Daylight Time
CEng	Chartered Engineer
CEPF	Columbus External Payloads Facility
CET	Central European Time
CETA	Crew and Equipment Translation Aid
CEVIS	Cycle Ergometer with Vibration Isolation and Stabilization
CHeCS MTL	Crew Health Care Systems Moderate Temperature Loop
CIR	Combustion Integrated Rack
CLA	Camera Light Assembly
CLPA	Camera Light Pan Tilt Assembly
CMG	Control moment gyroscope
CMO	Crew medical officer
CMSE	Certified Machine Safety Expert
CNC	Command and control
CNES	Centre National d'Etudes Spatiale (Centre for Space Studies)
CNN	Cable News Network
COLBERT	Combined Operational Load Bearing External Resistance Treadmill
COL-CC	Columbus Control Centre
COTS	Commercial Orbital Transportation Services
CQ	Crew Quarters
CRS	Commercial Resupply Services
CSA	Canadian Space Agency
CSA-CP	Compound Specific Analyser-Combustion Products
CSA-O2	Compound Specific Analyser-Oxygen
CST	Central Standard Time

CTC	Cargo transport container
CUCU CCP	COTS UHF Communications Unit/Crew Command Panel
CWA	Condensate Water Separator Assembly
CWC	Contingency water container
DDCU	Direct current to direct current convertor unit
DLR	Deutsches Zentrum für Luft- und Raumfahrt (German Centre for Flight and Space Flight), previously DVLR
DM	Descent Module
DMS	Data management system
DNA	Deoxyribonucleic acid
DoD	Department of Defense
DOUG	Dynamic Onboard Ubiquitous Graphics
DSM	Docking and Storage Module
DVD	Digital versatile disc
DWH	Digital Walk Holter
ECG	Electrocardiogram
ECLSS	Environment Control and Life Support System
ECO	Engine cut-off
EDT	Eastern Daylight Time
EEG	Electroencephalogram
EF	Exposed Facility
EFBM	External Facility Berthing Mechanism
EFU	Exposed Facility Units
EHS	Environmental Health System
EHS CDM	EHS Carbon Dioxide Monitor
EHS CSA-CP	EHS Compound Specific Analyser-Combustion Products
EHS GC DMS	EHS Gas Chromatograph/Differential Mobility Spectrometer
EHS VOA	EHS Volatile Organic Analyser
ELC	Express Logistics Carrier
ELM-ES	Experimental Logistics Module-Exposed Section
ELM-PS	Experimental Logistics Module-Pressurised Section
ELT	Experiment Laptop
EMU	Extravehicular Mobility Unit
EO	Main Expedition (Mir)
EOTP	Enhanced ORU Temporary Platform
EPM	European Physiology Module
EPO	Educational Program Operation
ERA	European Robotic Arm
ESA	European Space Agency
ESEF	European Science Exposure Facility
ESP	External Stowage Platform

ESPAD	ESP Attachment Device
ET	External tank
ETCS	External Thermal Control System
ETVCG	External Television Camera Group
EU	Experiment Units
EuTEF	European Technology Exposure Facility
EVA	Extravehicular activity
EWC	External Wireless Communications
ExHAM	Exposed Experiment Handrail Attachment Mechanism
FCF	Fluids and Combustion Facility
FCPA	Fluids Control Pump Assembly
FCV	Flow control valve
FFQ	Food frequency questionnaires
FGB	Functional Cargo Block
FI	Fire indicator
FIR	Fluids Integrated Rack
FMA	Force moment accommodation
FMK	Formaldehyde Monitoring Kits
FMPT	First Materials Processing Test
FSP	Functional Safety Professional
FSS	Fluid Servicer System
GLACIER	General Laboratory Active Cryogenic ISS Experiment Refrigerator
GM	General Motors
GMT	Greenwich Mean Time
GN&C	Guidance, Navigation and Control
GPC	General Purpose Computer
GPS	Global Positioning System
HAT	Hardware Attached on Top
HDD	Hard disk drive
HDEV	High Definition Earth Viewing
HEFU	HTV Exposed Facility Unit
HMS	Health Maintenance System
HRC	High-resolution camera
HRF	Human Research Facility
HRS	Heat Rejection Subsystem
HST	Hubble Space Telescope
HTV	H-II Transfer Vehicle
ICC-VLD	Integrated Cargo Carrier-Vertical Light Deployable
IDA	International Docking Adapter
IFM	Inflight maintenance
IMAX	Image MAXimum

IML	International Microgravity Laboratory
ISAS	Institute of Space and Astronautical Science
ISL	Integrated Station OpsLAN
ISLE	In-suit light exercise
ISP	Integrated Stowage Platform
ISS	International Space Station
ISU	International Space University
ITCS	Internal Thermal Control System
ITS	Integrated Truss Structure
IWIS	Internal Wireless Instrumentation System
JASDF	Japan Air Self Defense Force
JAXA	Japanese Aerospace Exploration Agency
J-CASMHR	JAXA Center for Applied Space Medicine and Human Research
JEF	JEM Exposed Facility
JEM	Japanese Experiment Module
JEM RMS	Japanese Experiment Module Remote Manipulator System
JEM RMS MA	JEM RMS Main Arm
JEM RMS MPEP	JEM RMS Multi-Purpose Experiment Platform
JICA	Japan International Cooperation Agency
JOCAS	Joint operator commanded auto sequences
JOTI	JEM ORU Transfer Interface
JSC	Johnson Space Center
JSDF	Japan Self-Defense Force
KhSC	Khrunichev State Research and Production Space Centre
KSC	Kennedy Space Center
LEE	Latching End Effector
LEO	Low Earth orbit
LF	Logistics flight
LTL	Low Temperature Loop
MACE	Mass Access Computer Equipment
MARES	Muscle Atrophy Resistive Exercise
MAS	Microbial Air Sampler
MAUI	Maui Analysis of Upper Atmospheric Injections
MBS	Mobile Remote Servicer Base System
MBS PDGF	Mobile Base System Power and Data Grapple Fixture
MBSU	Main Bus Switching Unit
MCC	Mission Control Centers
MCE	Multi-mission Consolidated Equipment
MCS	Motion Control System
MCS SIGI GPS	Motion Control System/Space Integrated GPS

MD	Doctorate of Medicine
MDCA	Multi-user Drop Combustion Apparatus
MDM	Multiplexer/demultiplexer
MEC	Medical Equipment Computer
MELFI	Minus-Eighty Laboratory Freezer for ISS
MERLIN	Microgravity Experiment Research Locker Incubator
METERON	Multi-Purpose End-to-End Robotic Operations Network
MIEI	Member of the Institute of Engineers of Ireland
MIIGA&K	Moscow State University of Geodesy and Cartography
MISSE	Materials on International Space Station Experiment
MLM	Multi-purpose Laboratory Module
MMOD	Micrometeoroid/Orbital Debris
MPC	Main processing computer
MPEP	Multi-Purpose Experiment Platform
MPLM	Multi-Purpose Logistics Module
MRC	Medium-resolution camera
MRM	Mini-Research Module
MSG	Microgravity Science Glovebox
MSP	Mission specialist
MSS	Mobile Servicing System
MT	Mobile Transporter
MWA	Maintenance Work Area
NASA	National Aeronautics and Space Administration
NASDA	National Space Development Agency (now part of JAXA)
NBC	National Broadcasting Company
NEEMO	NASA Extreme Environment Mission Operations
NOAX	Non-Oxide Adhesive eXperimental
NPR	National Public Radio
NRCSD	NanoRacks CubeSat Deployer
NTA	Nitrogen Tank Assemblies
NTSC	National Television System Committee
OAST Flyer	Office of Aeronautics and Space Technology Flyer
OBSS	Orbiter Boom Sensor System
OBT	Onboard training
OCS	Orbit Correction System
ODS	Orbiter Docking System
OGS	Oxygen Generation System
OIU	Orbiter Interface Unit
OMS	Orbital Maneuvering System
O-OHA	On-Orbit Hearing Assessment
OpsLAN	Operations Local Area Network

ORU	Orbital replacement unit
OSVS	Orbiter Space Vision System
OTCM	Orbital replacement unit/tool change-out mechanisms
OU	Open University
OV	Orbiter Vehicle
PAL	Phase Alternating Line
PCBA	Portable Clinical Blood Analyser
PCM	Pressurised Cargo Module
PCMCIA	Personal Computer Memory Card International Association
PCS	Portable Computer System
PCU	Power control unit
PDAM	Predetermined Debris Avoidance Maneuver
PDGF	Power and Data Grapple Fixture
PEC	Passive experiment container
PFCS	Pump Flow Control Subassembly
PFMC	Pump/Fan Motor Controller
PhD	Doctor of Philosophy
PLT	Pilot
PLT	Payload Laptop Terminal
PM	Project management
PM	Pressurised Module
PM	Pump Module
PMA	Pressurised Mating Adapter
PMM	Permanent Multi-purpose Module
PMP	Project Management Professional
POSSUM	Payload On-orbit Still Shots for Utilisation and Maintenance
PPA	Pump Package Assembly
PPL	Private pilot license
PS	Payload specialist
PVAA	Photovoltaic Array Assemblies
PVR 2B FQDC	Photovoltaic Radiator Flight Quick Disconnect Coupling
PWD	Potable water dispenser
PWS	Portable work stations
QD	Quick disconnect
R&R	Remove and replace
RAM	Radiation Area Monitor
RBVM	Radiator Beam Valve Module
RCAST	Research Center for Advanced Science and Technology
RCS	Reaction Control System
RELL	Robotics External Leak Locator
RGA	Rate Gyro Assembly

RHC	Rotational Hand Controller
RIGEX	Rigidisable Inflatable Get-Away Special Equipment
RINGS	Resonant Inductive Near-field Generation System
RKA	Russian Federal Space Agency
RLT	Robotic Manipulator System Laptop Terminal
RLT-BU	Robotics Laptop Terminal Backup
ROPE	Research on Orbital Plasma Electrodynamics
RPCM	Remote Power Controller Module
RPM	Rendezvous Pitch Maneuver
RRM	Robotic Refueling Mission
RS	Russian Segment
RSP	Resupply Stowage Platform
RSR	Resupply Stowage Rack
RSU	Remote Sensing Unit
RTOC	Return To Original Configuration
RWS PCS	Robotic Work Station/Portable Work Station
SAFER	Simplified Aid for EVA Rescue
SARJ	Solar Array Rotary Joint
SASA	S-Band Antenna Subassembly
SCOF	Solution Crystallization Observation Facility
SDA	Science Dream Association
SEITE	Shuttle Exhaust Ion Turbulence Experiments
SFAAM	Small Fine Arm Attachment Mechanism
SFU	Space Flyer Unit
SGANT	Space to Ground Antenna
SGTRC	Space to Ground Transmitter Receiver Controller
SIMPLEX	Shuttle Ionospheric Modification with Pulsed Local EXhaust
SLAMMD	Space Linear Acceleration Mass Measurement Device
SLEEP	Sleep-Wake Actigraphy and Light Exposure during Spaceflight
SLM	Sound-level meter
SLP	Spacelab Logistics Pallet
SLT	System Laptop Terminal
SM	Service Module
SMILES	Superconducting Sub-Millimeter-Wave Limb-Emission Sounder
SODF	Station Operations Data File
SOLO	SOdium LOad in microgravity
SpaceDRUMS	Space Dynamically Responding Ultrasonic Matrix
SPARTAN	Shuttle Point Autonomous Research Tool for Astronomy
SPDM	Special Purpose Dexterous Manipulator
SPHERES	Synchronized Position Hold, Engage, Reorient, Experimental Satellites

SPICE	Smoke Point in Co-flow Experiment
SRB	Solid rocket booster
SRMS	Shuttle Remote Manipulator System
SSC	Station Support Computer
SSE TF	SFA Stowage Equipment/Tool Fixture
SSHDTV	Super Sensitive High-Definition Television
SSIPC	Space Station Integration and Promotion Center
SSK	Surface Sample Kit
SSME	Space Shuttle Main Engine
SSOD	Small Satellite Orbital Deployer
SSPTS	Station to Shuttle Power Transfer System
SSRM	Space Shuttle Remote Manipulator
SSRMS	Space Station Remote Manipulator System
ST	Slide Table
STEAM	Science, technology, engineering, arts, and mathematics
STS	Space Transportation System
TAA	Triaxial accelerometer
TBS	Tokyo Broadcasting System
TCA LTL	Temperature Control Assembly/Low Temperature Loop
TCQ	Temporary Crew Quarters
TDRS	Tracking and Data Relay Satellite
TESS	Temporary Sleep Station
THC	Translational Hand Controller
TM	Transport Modified
TMA	Transport Modified Anthropometric
TOCA	Total Organic Carbon Analyser
TPS	Thermal Protection System
TRAD	Tile Repair Ablator Dispenser
TriDAR	Triangulation and LIDAR Automated Rendezvous and Docking
TRRJ	Thermal Radiator Rotary Joint
TSIS	Total and Spectral solar Irradiance Sensor
TsUP	RKA Mission Control Centre
TTCR	Trailing Thermal Control Radiator
TVIS	Treadmill with Vibration Isolation Stabilisation
UCCAS	Unpressurised Cargo Carrier Attachment System
UF	Utilisation flight
UHF	Ultra-high frequency
ULC	Unpressurised Logistics Carrier
ULF	Utilisation and Logistics Flight
UNOOSA	United Nations Office for Outer Space Affairs
UPA	Urine Processing Assembly

US	United States
USA	United States of America
USOS	US Orbital Segment
USSR	Union of Soviet Socialist Republics
UTC	Universal Time Coordinate
VC	Visiting crew
VHF	Very high frequency
VIP	Very important person
VIS	Vibration Isolation System
VolSci	Voluntary science
WAP	Wireless access point
WHC	Waste and Hygiene Compartment
WIF	Worksite interfaces
WinSCAT	Spaceflight Cognitive Assessment Tool for Windows
WORF	Window Orbital Research Facility
WPA DA	Water Processor Assembly/Distillation Assembly
WRM	Water Recovery and Management
WRS	Water Recovery System
WRS PWD	Water Recovery System/Potable Water Dispenser
YAC	Young Astronauts Club
ZSR	Zero-G Stowage Rack

Part I

Background

1

Before ISS

This introduction is a brief review of the history of Japanese human spaceflight prior to the construction of the International Space Station (ISS).

On 11 March 2011 the Tōhoku earthquake in the ocean floor east of the Japanese Oshika Peninsula caused a tsunami to strike the coast and send 40-m-tall waves as far as 10 km inland. Prior to the earthquake, Reactors 1, 2, and 3 of the Daiichi Nuclear Power Plant at Fukushima were active and Reactors 4, 5 and 6 were shut down for re-fueling. However, all 6 reactors still required cooling. After the earthquake, the active reactors were shut down by inserting control rods and because they were not generating power the backup diesel generators were needed to power the cooling pumps. The tsunami overcame the plant seawall 50 minutes after the initial shock and flooded all but one of the emergency generators. On 12 March, after the remaining generator failed, the backup batteries expired and the cooling pumps stopped, causing the fuel rods to overheat. Between 12 and 15 March, Reactors 1, 2 and 3 melted down and a series of hydrogen-air explosions released radioactive material into the atmosphere.

Some 32 km away, in the town of Takine, a shitake mushroom farmer heard the news, hung a radiation detector on his neck and fled in his truck. From his previous career as a journalist, he was suspicious of the authorities and the veracity of the news being broadcast. After spending some time with a friend in Koriyama, 60 km from Fukushima, he moved to Gunma Prefecture before finally giving up hope of returning to his farm. In November 2011 the former journalist and mushroom farmer accepted a position teaching agriculture at the Kyoto University of Art and Design.

This mushroom farmer and former journalist, Toyohiro Akiyama, could not even count the Fukushima disaster as the most eventful episode of his remarkable

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life. This is because when he flew to the Mir space station in December 1990 he became the first Japanese person in space.[1]

Born to affluent parents in Tokyo in 1942, Akiyama joined the newspaper club in his senior high school. After graduating from the International Christian University in Mitaka, Tokyo, he decided on television journalism as his career and joined the independent Tokyo Broadcasting System (TBS). His reasons included the fact that newspaper journalists had to start in regional bureaus, whereas he wished to remain in Tokyo. However, he was soon sent to London, where he was 'on loan' to the British Broadcasting Corporation (BBC) and issued Japanese language reports from there. After a stint back in Japan covering the Japanese political scene, he was sent abroad again, this time to Washington DC, where he was the bureau chief from 1984 to 1988. He covered the US-USSR Strategic Arms Reduction Treaty talks and the Reagan-Gorbachev Reykjavik summit.

As the USSR sought to monetise their space program, several western foreigners were flown to Mir in this period, with agreements with Austria, Germany and France, as well as a privately funded British project named Juno. But first there was a commercial deal with TBS which saw 163 candidates whittled down to Akiyama and TBS's only camerawoman, Ryoko Kikuchi. TBS were funding the flight with assistance from their sponsors Minolta and Sony. Reports of the cost of this mission to TBS range from $12 million to $37 million, with $7.4 million in ultimate losses.

Being a heavy smoker and drinker Akiyama never expected to fly, but when Kikuchi was struck down with appendicitis and ended up in hospital only a week before launch, he became the prime crewmember. His lack of fitness and his fondness for cigarettes upset some Soviet journalists who would have preferred the first journalist in space to have been Russian. Their campaign came to naught, probably because of the cash influx to the Glavcosmos commercial space program.

On 2 December 1990, Akiyama launched on board Soyuz TM-11 with commander Viktor Afanasyev and flight engineer Musa Manarov. The Russians would become the EO-8 resident crew of Mir. During the 2-day flight to the space station and the subsequent week on board it, Akiyama suffered from space adaptation syndrome (as many spacefarers do) but soldiered on, making live broadcasts to Japan when passing overhead and conducting experiments with six Japanese tree frogs.

He returned to Earth with the two Gennadis of the EO-7 crew, Manakov and Strekalov, in their Soyuz TM-10. Immediately upon landing Akiyama craved his beloved cigarettes, having foregone his four pack per day habit while in space.

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[1] Ellison Onizuka, born in Hawaii, USA, flew on the NASA Space Shuttle mission STS-51C on 24 January 1985. He was the first person of Japanese descent to fly into space. He died on his second mission when the Challenger broke apart after launch on 28 January 1986.

When asked about the most memorable thing that he saw from space, he said, "The scenes I saw from 400 km above the Earth. The diameter of the Earth is 13,000 km, so you can't see the Earth in its entirety if you are only 400 km away. But what still struck me as impressive was the shining blue Earth, which looked like one form of life floating in the universe. At the same time, I was reminded of the thinness of the blue layer, which is the atmosphere. So it made me visually aware that the atmosphere is so thin, and such a thin atmosphere protects every living thing – forests, trees, fish, birds, insects, human beings and everything."[2]

Wishing to learn and experience "the most basic human activity" of growing his own food, he left his wife, children, and job in Tokyo and moved to Fukushima where land was cheap. In his opinion, his family were used to his absences during his journalistic career and they visited him in the summers. He stayed there until the catastrophic events of March 2011.

Figure 1.1: Toyohiro Akiyama at the Kyoto University of Art and Design, August 2013 (Japan Times)

[2] *Japan Times* interview 3 August 2013.

The first official NASDA astronaut candidates were selected in August 1985. If it were not for the loss of the Space Shuttle Challenger on 28 January 1986, one of Takao Doi, Mamoru Mohri or Chiaki Mukai (née Naito) could well have beaten Akiyama to the honor of becoming Japan's first spacefarer. They all eventually flew in space, with Mohri going first, on board the Space Shuttle Endeavour for the STS-47 mission in September 1992.

Mamoru Mohri was born in Yoichi on the island of Hokkaidō on 29 January 1949. He was awarded a Bachelor's degree in Chemistry from Hokkaidō University, gained a Master's there also, and went on to earn a PhD from Flinders University in Adelaide, Australia. From 1975 to 1985 he worked on nuclear fusion and materials science research at Hokkaidō University.

Mohri went on to join the NASA Astronaut Group 16, known as The Sardines, in 1996 and become a Mission Specialist, but first, in 1992, he flew as a Payload Specialist for Spacelab-J, which was carried in the payload bay of STS-47. That was a joint NASA/NASDA life science and materials science mission on which 35 of the 44 investigations were sponsored by NASDA and two others were joint experiments. The NASDA designation for the mission was the First Materials Processing Test (FMTP). This flight was notable for a number of reasons. It was the first spaceflight by an African-American woman, the doctor and engineer Mae Jemison. It was also the first time a married couple travelled to space on the same mission. Mark Lee and Jan Davis began dating during training and got married in secret, only revealing their union after it was too late to replace one of them on the mission. It was not against NASA rules at the time for married couples to fly together, but a ban was later introduced to preclude the possibility of team dynamic problems. Lee and Davis have repeatedly denied rumors of sexual activity while weightless in space. They have since divorced.

After retiring from NASA in 2000 following his second spaceflight, Mohri became Chief Executive Director of Miraikan, the National Museum of Emerging Science and Innovation in Tokyo. On 16 March 2016 he was awarded Honorary Membership of the Order of Australia (AM) for services to Australia-Japan education and science relations, and on 16 April 2018 he received the Chevalier, Légion d'honneur, from France.

Japan's first woman in space was Chiaki Mukai, who launched on board STS-65 on 8 July 1994. She was born in Tatebayashi, Gunma Prefecture, on 6 May 1952. After graduating from Keio Girls' High School in Tokyo in 1971, Mukai went on to a distinguished medical career. After receiving her Doctorate of Medicine (MD) from Keio University in 1977 she was board certified for medicine. She worked in general surgery before gaining her PhD in physiology at Keio University in 1988, becoming board certified for cardiovascular surgery in 1989. Before being selected as a NASDA astronaut she was chief resident of cardiovascular surgery at Keio University Hospital and also an assistant professor in that subject at her *alma mater*.

Figure 1.2: Mamoru Mohri (Flinders University)

Mukai was selected as part of NASDA's 1st Astronaut Group in 1985. Prior to her first launch, from 1987 to 1988 she served as a visiting scientist at the Division of Cardiovascular Physiology of the Space Biomedical Research Institute at the NASA Johnson Space Center. From 1992 she was a Research Instructor of the Department of Surgery at Baylor College of Medicine in Houston. She was a visiting associate professor of the Department of Surgery at Keio University School of Medicine in Tokyo from 1992 to 1998. Also in 1992, she acted as crew backup and Spacelab communicator for Mohri's STS-47 mission.