SPACE ODYSSEY

VOYAGE TO THE PLANETS

BBC ONE

BBC FOUR

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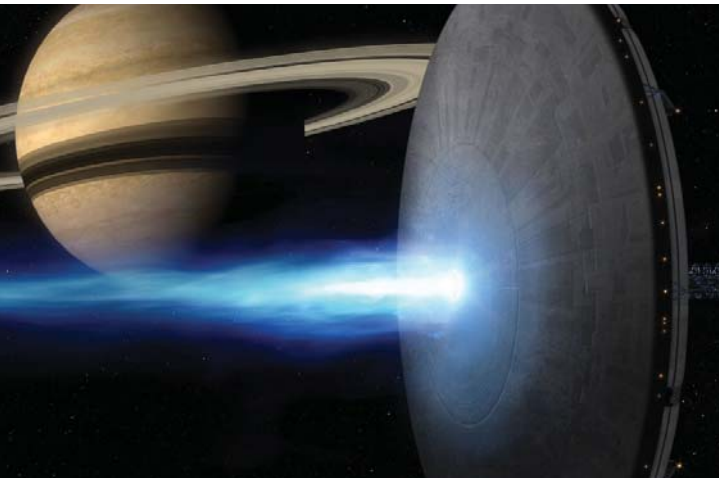
BBC LEARNING

The ultimate journey of human exploration comes to BBC One this November



Imagine crashing through the acid storms of Venus, taking a space walk in the magnificent rings of Saturn, or collecting samples on the disintegrating surface of an unstable comet. From the makers of *Walking With Dinosaurs*, this magical drama-documentary series, narrated by David Suchet, takes viewers on the ultimate space flight and, by pressing the red button on the remote control, transports them right to the heart of the European Space Agency's mission control room.

Seen through the eyes of five astronauts on a six-year mission to the new frontiers that make up our solar system, it reveals the spectacle – and the dangers – they face when landing on and exploring the exotic worlds of our neighbouring planets.

Using the latest scientific findings and feature film digital effects, *Space Odyssey: Voyage To The Planets* is the ultimate grand tour, brought to life in a beautiful and moving journey packed with peril and excitement. Along the way, it uncovers the immense physical and emotional challenges that would affect those taking such a trip. From a daring fly-by of the Sun, to a marathon mission to the frozen realms of Pluto, this epic voyage takes viewers on the adventure of a lifetime.

In a first for a TV series, the actors were filmed on parabolic flights to simulate zero gravity conditions so that they really are floating weightless in some of the scenes. Back on the ground, filming took place in some of the most inhospitable places on Earth to create a very real sensation of what it would look and feel like to walk on alien worlds. Award-winning film score composer, Don Davis, has created a spectacular soundtrack which brings the action, the drama and the sheer beauty of the scenery to life.

Executive producer, Tim Haines of Impossible Pictures, explains: *"In a unique collaboration between Hollywood's entertainment industry, the world's main Space Agencies and the cutting-edge digital effects talents of Framestore, this series is the most accurate vision of a human exploration of our neighbouring planets ever created."*

Producer, Chris Riley, continues: *"We worked closely with cosmonauts, astronauts and space agencies in Russia, Europe and the USA to bring a gritty reality to the series that reflects over 40 years of their experience of human space flight and robotic exploration of the planets of our solar system."*

Facts, figures and the science lowdown are available via interactive TV and the web, plus there's also a special touring show, designed for families, which will be visiting science centres around the UK.

To accompany this production, BBC Four broadcasts *Space Odyssey: The Robot Pioneers*, a 50-minute film revealing the real missions to the planets which have provided the facts that underpin the main series.

Space Odyssey: Voyage To The Planets is an Impossible Pictures production for the BBC, Discovery Channel and ProSieben.

Space Odyssey: The Robot Pioneers is an Impossible Pictures production for the BBC, Discovery Channel and ProSieben in association with the Science Channel.

The story: Part One

The interplanetary spacecraft Pegasus and her five-strong crew are launched into Earth orbit. Their epic six-year mission has begun. Forty one days from Earth lies their first encounter – with Venus. Although Earth's nearest neighbour, it could not be a more different world. With clouds of sulphuric acid, surface temperatures pushing 500°C, snows of metal encrusting mountain peaks and atmospheric pressures that could destroy a submarine, this is a hell-hole of a planet.

Astronauts Zoe Lessard and Yvan Grigorev make the nail-biting descent in a landing craft called Orpheus. Enveloped in a shroud of gases and plummeting to the surface in a fireball, Pegasus loses contact with them. Cocooned in the supremely re-enforced Orpheus, though, the astronauts land safely. Encased in an ultra-toughened titanium spacesuit, Yvan takes mankind's historic first steps onto the planet. His objectives are to collect samples, lay sensors to listen for volcanic eruptions and to retrieve a piece of a robot from a previous Russian mission, but it proves almost too much as the temperature inside his suit soars. With everything that's keeping them alive at its design limits, these two planet pioneers make their escape with only seconds to spare.

Mars is 150 million miles and 62 days of interplanetary travel away. Mission Commander Tom Kirby, medic and geologist John Pearson and exo-biologist Nina Sulman make their descent in another specially designed lander, Ares. This frozen, red planet should prove comparatively easy to explore compared to the ferocious conditions on Venus but, as Tom steps onto the surface, a dust devil, five times larger than anything on Earth, engulfs him. Fortunately, the Martian atmosphere is so weak that even these giant twisters are harmless. It does Tom no permanent damage, bar leaving a red hue all over his spacesuit!

Supported by a host of robotic explorers, they head for the edge of Valles Marineris – a canyon system a thousand times the size of Arizona's Grand Canyon. Their quest is to search for water in an attempt to discover life on Mars. Marvelling at the breathtaking views, the team is suddenly alerted to the imminent arrival of a solar storm carrying lethal levels of radiation. The safest place is inside Ares. Desperate to complete the experiments, their struggle back becomes a race for their lives.

Battling against radiation and giant dust storms, the team eventually complete their exploration of Mars and return to Pegasus. They must now cross the inner solar system for an unsettling, but necessary, close encounter with the Sun at temperatures approaching a staggering two million degrees centigrade. This accelerates Pegasus briefly to one million kilometres an hour, which helps propel them the next half a billion miles to Jupiter.

On the way, however, a scary brush with a rogue fragment of rock begins to erode the crew's trust in Mission Control back on Earth. As they crash into the top of giant Jupiter's immense atmosphere a few weeks later, there is concern that Control might have betrayed them again. Even more worryingly, flight medic John Pearson seems to be getting very sick.

The story: Part Two

Just over 200 days of travel from the Sun, Pegasus reaches the largest planet of the solar system, Jupiter. Its danger lies in a menace lurking at its core – a churning mass of liquid metallic hydrogen that inflates a magnetic bubble around the planet, producing levels of radiation 500 times the dose that would kill a human. To repel these lethal rays, Pegasus generates its own magnetic field.

Mission geologist Zoe is to land on Io, one of Jupiter's moons. As the most volcanically active world in the solar system, it's a geologist's heaven. This scientific bounty does, however, come at a price. Perilously close to the most lethal Jovian radiation belts, Zoe risks severe exposure but she's trained hard for this day and nothing is going to stop her exploring these exotic lava flows. Her exhilaration at being on the surface quickly turns to frustration when her spacesuit malfunctions. Even the most cutting-edge technology and millions of pounds of development still cannot guarantee safety in these other worlds. She is forced to cut the mission short. No samples are returned and, to her despair, half the expedition is a failure.

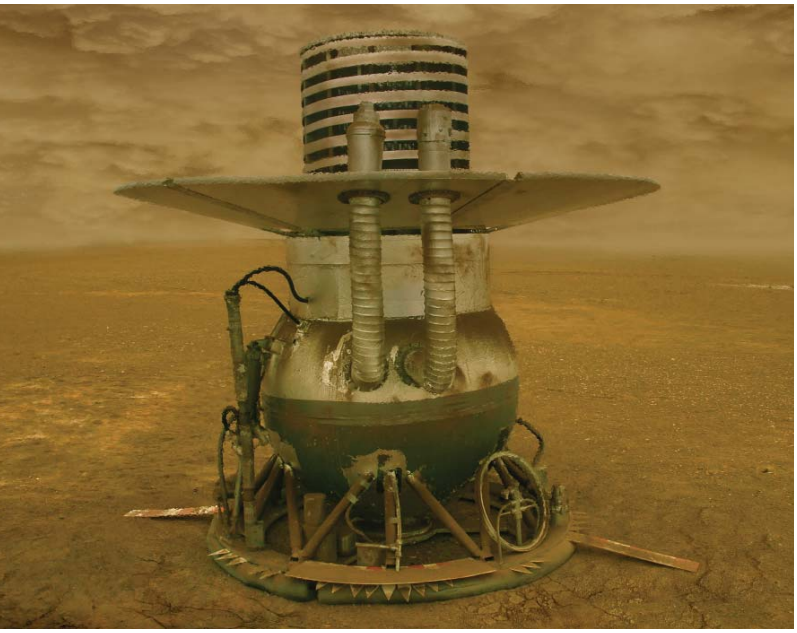
The ringed world of Saturn is almost a year of interplanetary travel away. By the time they reach it, medic John is seriously sick and deteriorating rapidly. He seems to have been exposed to a lethal level of radiation as Pegasus passed the Sun. Amongst a mesmerising trillion shards of ice and rock tumbling in endless rings around this gas giant, crew member Nina Sulman conducts a spacewalk. She collects a fragment for testing, hoping it will help establish the rings' origins and age. By the time she returns, John has passed away, no longer able to fight the radiation in his body.

His death is a terrible blow to the astronauts. Torn between returning to Earth or venturing on to Pluto, at the edge of the solar system, the psychological stress takes it toll and the crew take the unprecedented step of cutting contact with Mission Control whilst they make up their minds. Eventually, the astronauts re-establish communication having decided to continue on their Plutonian path.

Almost two years elapse before Pegasus draws close to the tiny frozen world of Pluto, its massive moon hanging close by. Tom and Yvan make the descent and spend 10 days constructing a telescope which will remain on the surface after they leave, scouring the Galaxy for other Earth-like planets.

Heading for home, there is one final mission for Zoe and Nina: to land on a newly observed comet, Messier, to sample pristine material from the birth of the solar system in a search for the organic building blocks of life. Resting inside their lander, the comet suddenly starts breaking up without warning, shedding material into space and blocking their safe return to orbit. They make a dramatic emergency launch to bring them within sight of Pegasus, but comet debris has breached its hull, injuring Yvan. Tom is busy fighting a fire on-board. The safety of Earth suddenly seems a long way off...

Space Odyssey: The Robot Pioneers



To accompany *Space Odyssey: Voyage To The Planets*, BBC Four broadcasts a documentary that looks at the history of space exploration to reveal the science behind the series. It tells the story of the human ingenuity that has dispatched robotic missions to all the planets except, as yet, Pluto.

Voyager 2 – which accomplished the original grand tour of the planets in the Seventies and Eighties, is a prime example. Incredibly, more than 25 years since its launch and now over seven billion miles from Earth, we can still hear its whispers from deep space. It carries the spirit of human exploration like a metal Christopher Columbus as its sensors probe the edge of our planetary system. Human space flight has always overshadowed such extraordinary robotic quests but this documentary seeks to unveil their secret history.

Since the first Russian robot flew round the moon in 1959, more than 160 incredible metal explorers have diced with disaster, enduring multi-billion mile missions to unwelcoming worlds and dramatic journeys of discovery and survival that rival the tale of Apollo 13. They've trail blazed a priceless path for any future manned missions, with their maps, measurements and images providing the knowledge for *Space Odyssey: Voyage To The Planets*. Every amazing event, experience and danger portrayed in the series is based on the findings of these real robotic missions.

The sturdy Russian Venera landers survived blistering temperatures, acid storms and submarine-crushing pressures to snap tantalising images of the surface of Venus in the Seventies and Eighties. This allowed the production team to accurately recreate this most extreme volcanic surface and know that, to ensure their survival on the surface long enough to carry out their mission, a human explorer would have to be equipped with a super-cooled titanium suit.

NASA's Viking landers endured five years of daily sub-Siberian winter temperatures whilst hunting for life on Mars. Their experiences on the surface of the red planet enabled *Space Odyssey: Voyage To The Planets'* depiction of this frozen desert world and left the fictional Pegasus crew with no doubts about the stamina they'd need to leave their own footprints in the Martian dust.

Braving the debilitating radiation belts of giant Jupiter, the Galileo mission survived for eight years. It watched the planet's weather systems and charted the four big moons – snapping tantalising details of the volcano fields of Io and the ice-rucked surface of Europa – enabling the accurate digital representations of these exotic worlds created for the main series.

Thanks to the dedicated spacecraft engineers and the glass eyes and metal limbs of these remarkable mechanical explorers – and many more not mentioned here – this series is able to accurately portray the gruelling reality of a deep space human journey to the planets.

Take the journey further…

BBCi – interactive TV

Although the action in *Space Odyssey: Voyage To The Planets* is dramatised, it is all based on existing technology and knowledge collected during actual missions to the planets. Digital TV offers a chance for viewers to delve further simply by pressing the red button on the remote control.

At any point during both of the episodes, viewers can choose to access the *Mission Report*. This is a virtual mission control interface featuring pop-up facts that will highlight the background research from which the series was made. In addition, it provides extra information and context for each scene. It will answer questions such as: Why do the astronauts have to exercise so much?, Why don't the astronauts eat bread?, and Why is Mars so cold and Venus so hot?

If viewers have further questions not answered in the programme or the Mission Report, they can submit them via e-mail, SMS or by Digital satellite return path. These will be answered in a special live broadcast from the European Space Agency Mission Control, where some of this series was filmed. Accessed by pressing the red button, viewers will meet a team of experts - planetary and rocket scientists, real astronauts and the programme-makers - who, as well as answering their questions, will be demonstrating what conditions are really like on the different planets, giving the insider's track into the missions currently sailing round the solar system, and unveiling plans to send a manned mission to Mars.

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Visit the info-packed website to learn more about Pegasus and the other spacecraft in *Space Odyssey: Voyage To The Planets*, and get to know the principal crew members by reading their detailed profiles. With *Space Doctor Interactive*, get to grips with the physiological effects of space travel by taking on the role of a doctor who has to look after the health of a crew on a mission to Mars.

Imagine planning the holiday of a lifetime to the planets or their moons – an online travel guide gives all the facts and information needed. There's also a Solar System Jigsaw which lets users "build" the solar system themselves and see how the planets orbit the sun.

The Tour

Space Odyssey: Voyage To The Planets hits the road with a series of events across the country. Aimed at families with children aged seven and over, the events will take place at venues including the Science Museum in London, Manchester Science Museum, the National Museum of Scotland and the National Space Centre in Leicester.

Producer and former planetary scientist, Chris Riley, will take visitors on a whistle-stop tour of the solar system and, along the way, uncover some of the science behind the series. There will be previously unseen footage, live demos and a chance to find out what we know about our nearest neighbours in space.

For more information on venues and dates, visit **bbc.co.uk/science**

Profiles of the main characters

The Astronauts

Tom Kirby: Mission Commander (played by Martin McDougall)
Pilot and navigator. Military trained. Responsible for navigation, braking manoeuvres, guiding secondary craft to and from planet surfaces. Team leader whose decision is final in the event of loss of contact with Mission Control.

Yvan Grigorev: Flight Engineer (played by Rad Lazar)
Engineer, electronics and computer systems analyst. Highly trained in mathematics, physics, chemistry and meteorology with secondary training as a pilot and navigator. Second in Command.

Zoe Lessard: Mission Scientist (played by Joanne McQuinn)
Science Officer specialising in geology, geomorphology, meteorology, remote sensing, geochemistry and hydrology. Secondary training in computer sciences and engineering and spacecraft systems. In charge of food, water and other supplies.

John Pearson: Flight Medic (played by Mark Dexter)
Medical doctor. Secondary training in biology, exo-biology and geological sciences. Trained cameraman, official mission biographer and media liaison person. Responsible for monitoring environmental and personal health.

Nina Sulman: Mission Scientist (played by Michelle Joseph)
Science Officer specialising in biology and chemistry (especially organic chemistry). Emergency Medicine trained. In charge of experiment equipment and its preparation, sample processing, logging and storage.

Mission Control

Alex Lloyd: Chief Scientist, Pegasus Mission (played by Mark Tandy)
Inter-disciplinary scientist. He ensures that as much science as possible is squeezed out of every opportunity on the flight.

Claire Granier: Chief Flight Surgeon (played by Hélèn Mahieu)
Responsible for the overall physical and mental health of the crew. In consultation with on-board medic John Pearson, she works to ensure the crew aren't over-stressed by the requirements of the mission.

Fred Duncan: Flight (played by Colin Stinton)
Director of the mission. Flight has a background in aeronautics and astronautics and a good knowledge of all the spacecraft systems and the extensive and complex objectives of the mission.

Larry Conrad: Capcom (played by John Schwab)
An experienced astronaut, familiar with the minutiae of the mission procedures, the systems and challenges of the spacecraft, and the rigours of living and working in space.

Isabel Liu: Flight Dynamics Officer [Fido] (played by Lourdes Faberes)
Responsible for the engine burns to get in and out of planetary orbits and onto the trajectories of interplanetary flight.

Space School – Turning actors into astronauts

It was crucial that the actors in the series were able to portray as realistically as possible the lives of the astronauts they were playing. So, the programme-makers put them through a crash course in space flight and exploration by sending them to their very own *Space School*.

The *Space School* tutors included Prof Chris Welch, a spacecraft engineer and principle lecturer in astronautics at Kingston University; Dr Kevin Fong, co-director of UCL's centre for extreme environment medicine; Jean Pierre Haignéré, one of only two European astronauts to spend six months on-board the Mir space station; and David Scott, Commander of the Apollo 15 mission to the Moon and a technical consultant on the *Apollo 13* movie.

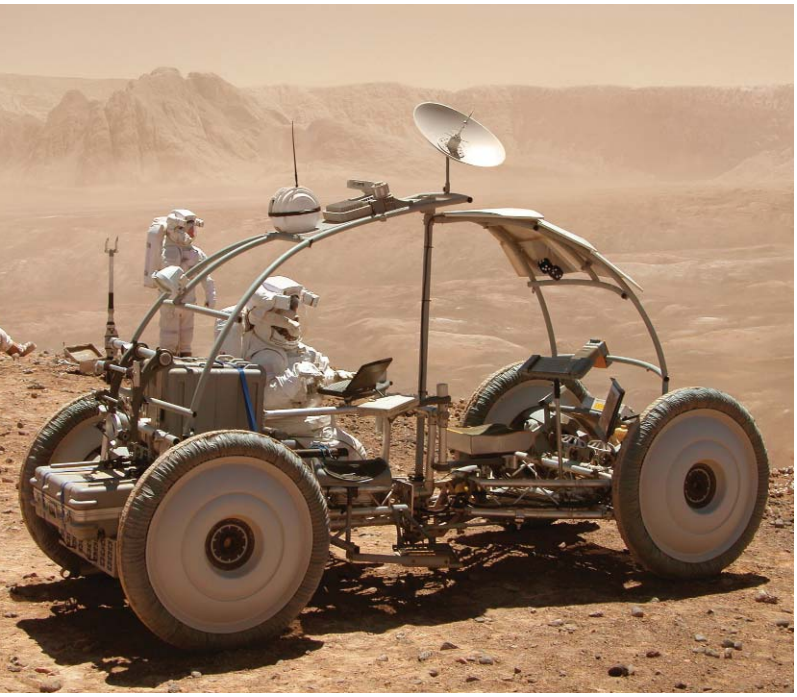
To ensure convincing performances, the actors trained hard in the spacecraft sets, practicing launch and landing procedures, until they could find all the right buttons and controls with their eyes closed. The British National Space Centre in Leicester then put them through special team-building exercises so they were able to build up rapport and bond quickly to ensure that, on screen, it would feel as if they'd been training together for years, as would have been the case if this were a real mission.

Spending any amount of time in space has an effect on an astronaut's mind and body, but a mammoth six-year trip would undoubtedly place a huge strain on a person's psychology and physiology. The experts explained the facts, whilst the astronauts discussed their own experiences and reactions to stress and dangerous situations. This gave the actors a firsthand understanding of the real-life pressures of space travel, enabling them to portray their characters as credibly as possible.

Another integral part of the actors' once-in-a-lifetime training experience was to spend a week at the world-class Yuri Gagarin Cosmonaut training facilities at Star City, just outside Moscow. The team spent time on spacecraft simulators there, sharing time with a crew bound for the International Space Station. Here, the actors practised space walks in a massive neutral buoyancy tank where they floated around a full-scale space station mock-up, and rode the extreme Gs of the largest covered centrifuge in the world.

Then came the ultimate ride. The actors (in real space suits), props, spacecraft sets and filming team were loaded on-board a colossal cosmonaut-training cargo plane which flew a series of stomach churning parabolic curves – climbing hard then heading into a steep dive – to mimic zero gravity. The contents of the plane are effectively in free-fall, creating weightlessness for all those on-board … and nausea!

The sets and costumes



To ensure that the look of the series felt contemporary and convincing, the series producers turned to the companies that had helped to create some of the most authentic and spectacular space movies of our time.

Wonderworks, the Los Angeles master space set-builder behind *Apollo 13*, *From The Earth To The Moon*, *Space Cowboys*, *The Core* and *The Day After Tomorrow*, built and supplied most of the sets for this series.

A modified space shuttle cockpit fitted with a slightly more futuristic "glass cockpit" formed the Pegasus command centre, and Wonderworks' unique International Space Station set used in *The Day After Tomorrow* was adapted for the mothership's lab areas. The sets were shipped across the world and reconstructed at two studios to the west of London. Some parts were then taken to Russia and rebuilt on-board a cosmonaut training cargo plane to fly real weightless aerobatics.

The Hollywood costume house, Global Effects, who supplied space suits for *Apollo 13*, *Deep Impact*, *Armageddon*, *Contact* and the TV series *Earth To The Moon*, designed and built the Venus and Io suits used in this series. The company also modified their space shuttle EVA (spacewalk) suits from *Space Cowboys* for the actors' Mars, Pluto and comet scenes. Working with their technicians in the deserts of Chile and on the planetary surface sets at Pinewood studios, the crew were able to use costumes that are hard to tell from real multi-million dollar suits.

"We merged these ultra-accurate costumes with real cosmonaut space suits in some scenes, and this reflects something we've tried to do throughout the series – fusing reality with mock-ups," explains the producer. *"I believe we are actually the first TV production to make use of real space suits in a drama."*

It wasn't just the costumes that were authentic. Many of the props seen in the drama are also real products developed for missions to the International Space Station (ISS) and supplied to the production by the European Space Agency and Rosaviakosmos (the Russian Space Agency). From the personal hygiene packs to the food parcels, much that you see on screen is the real thing.

"Plus, by using NASA and ESA footage shot on-board and outside the ISS, we have tried to blur the boundaries between the real missions and ours even further," says executive producer, Tim Haines. He continues: *"Even the astronauts' dialogue with Mission Control has, in places, been purposely distorted in order to convey the difficulties of communicating across the vast distances of space."*

Shaping the look of the series in this way, by combining the best that Hollywood's space movie specialists have to offer with real spacecraft equipment and following the advice of planetary scientists and spacecraft engineers working in the field, the series producers aimed to achieve a look and feel that's hard to distinguish from footage shot on real missions.

Spacecraft: The facts

All the spacecraft in the series were designed in a collaboration between the production's Art Department, specialist consultant Dr David Baker and engineers at EADS-Astrium, a world-class spacecraft manufacturer.

Commenting on the authenticity of the technology used, series consultant Dr David Baker explains: *"The spacecraft and landing vehicles depicted throughout the series adhere to strict principles of spacecraft engineering. They are based on genuine designs and technologies currently being researched and developed at NASA's field centre studies on advanced missions."*

Adrian Russell, Head of Future Concepts at EADS Astrium adds: *"We were extremely pleased to be invited to participate in this exciting programme. The spacecraft were an exhilarating and challenging design task for us – ensuring they were based on credible materials and engineering concepts, whilst still being capable of completing the mission that the story demanded."*

One of the more innovative technologies featured in the series is the magnetic shield Pegasus generates to protect the crew from intense radiation environments around the Sun and Jupiter. Magnetic fields like this are already being used to conduct experiments, for example, in areas where electrical forces are deflected for scientific and safety purposes. The generation of artificial magnetospheres for use on spacecraft is something that is being further researched at the University of Washington in Seattle, who were also consulted by the programme-makers. Their use on Pegasus, therefore, is an extension of existing scientific practices, but on a grander scale.

Pegasus: the mothership

- Length: 1.3 km
- Weight: just over 400 tonnes
- Aeroshield is constructed from steel, carbon fibre and beryllium
- Powered by a mighty nuclear fusion reactor with a core temperature of 100 million degrees that explosively vaporises the chilled liquid hydrogen propellant
- Can withstand temperatures of over 5,000°C
- The main engine can generate over 158 million horse power of acceleration
- Top engine speed of 288,000 kmph, although Pegasus is designed to withstand speeds of a million kmph which it's hurled to as it passes the Sun
- Has the same internal space as 10 jumbo jets
- Carries 57 tonnes of food, 80 tonnes of oxygen
- During the 2,246 days of the mission, it will travel 8.3 billion miles
- Pegasus is named after the winged horse from Greek mythology and the constellation where extra-solar planets were first discovered

Orpheus: Venus lander

- Height: 12 metres
- Weight: 35 tonnes
- Constructed from toughened titanium alloy to withstand high-speed entry through sulphuric acid clouds
- Designed to withstand 900 tonnes of air pressure per square metre of its surface and temperatures of 500°C (hot enough to melt lead and zinc)
- Launch engine – a toroidal aerospike – capable of reaching the Venus escape velocity of over 10km/second in just under eight minutes
- Only one window cut from a single diamond to withstand the strongly acidic upper atmosphere
- Drag Chute made of acid-resistant zirconium alloy
- Glide Chute made of 30-metre wide zirconium and carbon-fibre canopy
- Orpheus is named after the poet and musician of Greek myth who visited the underworld to try to rescue his wife

Ares: the Mars lander

- Height: 25 metres
- Weight: 45 tonnes
- Capable of sustaining a crew of three on the surface of Mars for up to a month
- Launch Engine – toroidal aerospike – capable of reaching the Mars escape velocity of five km/second within five minutes
- Three windows made of toughened high-strength polycarbonate
- Carries electrically powered Martian Rover vehicle for surface exploration
- Radiation shielding: inner core storm shelter formed from multi-laminate polythene
- Glide Chute is rip-resistant triple laminate nylon and is larger than a football pitch to enable it to glide in the low air pressure
- Named after Ares, the Greek god of war and the equivalent of the Roman God Mars

Hermes: the Io lander

- Height: 10 metres
- Mass: 15 tonnes (2.7 tonnes on Io)
- Carries enough air and water supplies to sustain an astronaut for 36 hours
- Designed entirely to shield occupant from the harshest effects of Jupiter's radiation belts
- Special Properties: radiation-hardened electronics with physical and active radiation shielding guaranteed to protect up to levels of 2000 RADs
- Two triangular windows made of aluminised 12-layer glass-polythene laminate with 10cm thick hydrogen-rich radiation shield shutters
- Five legs which are only strong enough to support it on the 1/6th gravity environment on surface of Io
- Powerful flood lights to illuminate the landing site during an Ionian night
- Named after Hermes, the Greek messenger God

Clyde: the Pluto lander

- Height: 15 metres
- Weight: 28 tonnes (1.87 tonnes on Pluto)
- Special properties: ultra-thin titanium skin with thick aerogel on the interior to insulate against numbing chill of the planet
- Powerful floodlights to illuminate the telescope construction site during the 26-hour Plutonian nights
- Capable of sustaining a crew of two for up to three weeks
- Powered by a hatbox-sized nuclear reactor set up on the surface and powered up remotely. This also supplies the power to the telescopes once the mission has left
- Named after the American astronomer who discovered Pluto, Clyde Tombaugh

Messier: the comet lander

- Height: 12 metres
- Mass: 29 tonnes
- Rocket Engine: multiple motors positioned above and below the spacecraft to push it towards the ultra-low gravity environment of the comet's surface
- Rocket-propelled harpoon tethers to capture the landing site on the comet with heated tips to penetrate the deeply frozen comet floor
- Chilled landing pads to stop the legs melting the surface and then refreezing and getting stuck to it
- Bulletproof "Whipple-shield", a multi-laminated impact shield nose canopy to protect the spacecraft from the high-speed debris cloud impacts, which could be encountered around a comet
- Multi-laminate self-repairing fuselage to offer extra protection against cometary debris
- Ultra-manoeuverable lander capable of the delicate rendezvous it needs to make with the comet
- Named after the French astronomer who surveyed many comets during the 18th century

Space Oddities

- The crew of Pegasus were weightless for three times longer than the first American in Space – Alan Shepard – whose Freedom 7 spacecraft carried him on a parabolic trajectory producing just five minutes of weightlessness on his 15-minute flight in May 1961.
- The Mars scenes were filmed at the Atacama Desert in Northern Chile, where the World's Space Agencies test their Mars robotic rovers. Whilst filming, researchers in Mexico University actually declared it the most Mars-like place on Earth.
- Mars was the closest it had been to Earth for 60,000 years whilst the film crew were preparing to recreate the planet in Chile's Atacama Desert.
- Since there are no oceans on Mars to hide surface details, we have been able to map more of this red world than we have of Earth.
- Just before filming the solar flare sequence for the series, the largest solar flare ever recorded erupted from the Sun. Images of this eruption were used in the scenes at Mission Control.
- The day the crew filmed scenes of the mission nearing Pluto, headlines in the papers announced that one of NASA's robotic Pioneer spacecraft were reaching the edge of the solar system too. The newspaper was used as a prop in the scenes at Mission Control.
- On Venus, the Sun (could you see it) crosses the sky 100 times more slowly than on Earth. It takes two weeks for dusk to fall and the Sun sets in the east. Sunset is followed by an interminable night that lasts longer than one of Earth's seasons. It is so hot that lead and zinc would form rock pools and mountain peaks get dusted with a metallic "snow" of iron pyrites and germanium.
- In 1938, Orson Welle's radio dramatisation of *War Of The Worlds* – in which a realistic news broadcast described a Martian invasion of Earth – sent a million Americans into panic.
- The Sun is currently the most studied object in the solar system. Via the internet, people can watch solar storms rage, check today's solar weather forecast and find out how much radiation will be thrown at Earth in the next few hours.
- Saturn was the last planet the probe Voyager 1 visited. It used the planet's gravity to hurl it over the north pole of the planet's largest moon, Titan, and on, up and out of the plane of the solar system. In 2003, this vintage probe reached 90 astronomical units from Earth – 90 times the distance between Earth and the Sun, a total of 13.5 billion km, making it is the most distant man-made object in the universe. It has enough power to operate until 2020, by which time it will be almost 22.5 billion km from Earth.
- The space sport of zero-G tennis was invented on shuttle flights in the Nineties. The ball is a lump of gaffer tape and clipboards are used as rackets. There's no net but points are gained if an opponent misses a shot. Apart from that, it's a free-for-all – forehand, backhand, upside down, overhead, off the wall…
- Until just over 10 years ago, the nine planets of the solar system were the only ones known to man. Since then, around 120 extra solar planets have been found because it was discovered that large planets have just enough gravity to make their stars wobble a little. Once astronomers figured out how to detect this tiny wobble, planets started popping up all over the place.
- No laws of physics were broken in the making of this series. Although the propulsion systems and active magnetic shielding are still just concepts, they are more imaginable to scientists today than Concorde would have been to the Wright brothers.

Jargon guide to space and spacecraft

A guide to some of the astronaut lingo used in the series:

Auto Sequencer – A computer system used to co-ordinate a flight procedure such as a launch, a landing or a docking.

"Cryogens at 36 psi" – Cryogens refers to the engine propellant that is chilled and compressed to turn it into a liquid, making it easier to store. 36 psi is the pressure in pounds per square inch used to monitor how much pressure it is under. The main cryogen stored on Pegasus as a propellant is liquid hydrogen.

Delta V – the change in velocity; the acceleration.

EVA – Extra-Vehicular Activity or spacewalk. The term refers to an astronaut doing something outside the spacecraft.

Heat Shield Load – the amount of temperature the shield is exposed to.

Magnetic Flux – A reference to the changing levels of magnetic field that the surface of Io is exposed to from nearby Jupiter.

Magnetic Loop fields – Gnarled and twisted arcs of plasma that seem to flow along magnetic field lines that protrude from the surface of the Sun.

MMU – Manned Manoeuvring Unit or jet pack. A sort of strap-on spacecraft that allows an astronaut in a spacesuit on an EVA to manoeuvre freely without being tethered to a spacecraft.

Pitchover – During launch, a spacecraft will tip over, often to let the pilot keep an eye on the horizon all the way into orbit.

Power Bus – A spacecraft is made of a series of individual sections called buses. The power bus is the section that houses the power generating parts of the craft.

Quakes – Slang for seismic activity on the surfaces of the rocky moons and planets.

Retro burn – Burning a rocket motor in a reverse direction to slow down the speed of a spacecraft.

Solar quakes – The solar equivalent of earthquakes. Caused by immense releases of energy deep inside the Sun and flares snapping off the surface. These events cause the whole star to reverberate.

Space Assets – The hardware in space used to support the mission, such as the extra communication satellites, the solar weather satellites, the fuel and food dumps etc

TMI – Trans Mars Injection, the engine burn that accelerates Pegasus away from Venus' orbit and on to a course towards Mars.

Yaw – A tilt of the spacecraft to rotate it left and right.

Jargon guide to mission control

Capcom, Flight, GNC, Surgeon… These Mission Control buzz words appear on many space films, but who are these people and what role do they play in keeping the mission on track and the crew alive?

FLIGHT: Flight Director. Call sign "Flight" – leader of the flight control team. Responsible for overall mission and decisions that will keep the crew safe and healthy, whilst maximising results.

MOD: Mission Operations Director. Call sign "Mod" – the main liaison between the control room and the upper echelons of the main space agencies running the mission.

CAPCOM: Spacecraft Communicator. Call sign "Capcom" – serves as the primary communicator between flight control and astronauts. The abbreviation is a throwback to early manned spaceflight, when the first spacecraft were actually capsules.

FDO: Flight Dynamics Officer. Call sign "Fido" – defines Pegasus' performance and capability during aerobraking and orbital manoeuvres. Plans the burns to get in and out of planetary orbits and co-ordinates advice on lander manoeuvres.

GDO: Guidance Officer. Call sign "Guidance" – ensures the onboard navigation and on-board guidance computer software guarantees Pegasus is always on target.

SURGEON: Flight Surgeon. Call sign "Surgeon" – monitors crew activities, co-ordinates medical operations control team, provides crew consultation, advises Flight Director of the crew's health.

PROP: Propulsion Systems Engineer. Call sign "Prop" – monitors and evaluates reaction control and orbital manoeuvering systems during all phases of flight, and manages propellants and other consumables available for manoeuvres.

GNC: Guidance, Navigation & Control Systems Engineer. Call sign "GNC" – monitors all vehicle guidance, navigation and control systems. Notifies Flight Director and crew of impending abort situations, advises crew regarding guidance malfunctions.

EECOM: Emergency, Environmental & Consumables Systems Engineer. Call sign "EECOM" – monitors on-board life-support systems, cabin pressure, temperature control systems, air and water recycling systems.

EGIL: Electrical Generation & Integrated Lighting Systems Engineer. Call sign "Eagle" – monitors cryogenic levels of fuel cells, electrical generation, distribution systems, vehicle lighting.

INCO: Instrumentation and Communications Systems Engineer. Call sign "INCO" – plans and monitors in-flight communications and instrumentation systems configurations.

GC: Ground Control. Call sign "GC" – directs maintenance and operation activities affecting Mission Control hardware, software and support facilities, and the big global network of dishes that listen out for communications from Pegasus.

SCIENCE: Science Officer. Call sign "Science" – co-ordinates the complete programme of science undertaken in flight, planetary and moon orbit and on the surfaces of worlds visited.

How we know what we know –
The real missions behind Pegasus' journey

The series-makers used facts collected by hundreds of robotic missions to the planets in order to construct the most accurate and realistic human experiences of walking on these exotic worlds. Detail about their atmospheres, rock formations and gravity fields have been gathered over the last 40 years.

The colours, sights, sounds and smells encountered by the astronaut explorers in the series are as predicted by planetary scientists who have already been there – experiencing these alien planets and moons through these robotic emissaries. The information below provides summaries of the accomplishments and discoveries of the real trail-blazing robots.

Venus
Today, 98% of the surface of Venus has been mapped by radar from Earth and orbiting Russian and American spacecraft. They revealed a world covered in volcanic features ranging from tiny craters to continent-sized features. The Russian Venera landers took panorama images of their landing sites. In this series, the crew's descent through the Venusian atmosphere and their experiences on the surface are based on the results of these missions. Working with the Russian mission team who designed and built Venera 14, their robotic lander was rebuilt and aged in the way these scientists believe it would have been altered by decades sitting on one of the most extreme surfaces in the solar system.

Mars
There have been more robotic missions to Mars than to any other world and, today, there are more complete maps of its surface than Earth's. NASA's Mars Odyssey and Global Surveyor satellites and ESA's Mars Express orbiter provided detailed maps of the surface and subsurface, as well as detailed observations of its weather and climate. Robotic landers and rovers have recorded the chemistry, mineralogy and microscopic textures of the ground and it has become clear that liquid water played a big part in shaping the contours of Mars. To film the Mars scenes, the cast and crew went to the remote Atacama Desert of northern Chile, deemed "Mars-like" enough by NASA to be a testing ground for its future missions to the red planet.

Sun
Solar Science has progressed enormously in the last decade. There's now an armada of international robotic missions scrutinising it. NASA's TRACE mission, the NASA/ESA Soho satellite and Japan's Yohkoh mission have been sending back stunning images of the tormented solar surface, twisted and gnarled by the potent magnetic forces emanating from deep within. An ESA/NASA mission – Ulysses – has made four giant, one billion mile-wide orbits of the Sun, providing the first-ever map of the heliosphere from the equator to the poles. The views shown in the series are modelled entirely on the images from these missions. To protect the crew from the lethal levels of radiation, they pass by the Sun during a period of quietness called Solar Minimum, with Pegasus shielded by an artificial, on-board magnetic field – a technology currently being researched at the University of Washington in Seattle for possible future propulsion.

Asteroid Belt
This 80 million km thick band of debris is known to stretch out for 280 million km. Over 48,000 asteroids are catalogued but there's over a million more waiting to be found. The Pegasus crew encounters one of these unknown asteroids. It is modelled on observations from a number of robotic missions that have flown past, orbited and even landed on these tiny worlds, in particular NASA's Near Earth Asteroid Rendezvous (NEAR).

This spacecraft orbited and mapped the surface of an asteroid called Eros for a year then survived a crash landing onto it and continued to send back useful data and pictures.

Jupiter & Moons

The first probes to visit Jupiter – NASA's Pioneer 10 and 11 missions – discovered that its magnetic field captures charged particles thrown out by the Sun and accelerates them to incredible speeds generating dangerous radiation amounting to over 1,000 times the lethal dose for a human. A few years later, NASA's famous Voyager 1 and 2 spacecraft sent back thousands of pictures and gigabytes of data, charting the planet's immense weather systems and imaging its moons. In 1995, NASA's Galileo mission dropped a probe into the planet's atmosphere which relayed data on temperatures, pressures, wind speed and cloud. The orbiter spent eight years scrutinising the whole Jovian system and making multiple fly-bys of the four main moons. In December 2001, Cassini also flew past Jupiter on its way to Saturn. The details of Pegasus' encounter with Jupiter and the crew's exploration of the moons, Io and Europa, are taken entirely from the results of these missions.

Saturn & Moons

So far, three probes have gone to Saturn. In the Seventies, Pioneer 11 navigated across the ring plane and discovered its 11th moon, two new rings and that it had a magnetic field a thousand times stronger than Earth's. Voyagers 1 and 2 sped past in 1980 and 1981 studying the planet's vast weather patterns, the dynamics of the rings and the orbits of its moons. In 2004, the joint ESA/NASA mission, Cassini-Huygens, reached Saturn, going into orbit for a four-year study of the system. In 2005, the Huygens probe will drop into the atmosphere of Titan, taking images and recording weather patterns as it falls towards the surface where, if it survives, it will conduct a series of further experiments designed to analyse the environment it finds. The Saturn encounter in the series is based entirely on these missions.

Pluto-Charon

Pluto remains the only planet never to have been visited by a spacecraft but, since the Eighties, it has passed in front of numerous stars giving astronomers the chance to make precise measurements of its size and revealing a very thin atmosphere made mostly of nitrogen. The best images of this planet come from the Hubble space telescope. Through these observations, it is thought the surface resembles that of Neptune's moon, Triton. Voyager 2 flew past Triton in 1989, so Pluto's landscape was recreated for this series using the detailed pictures it took. A NASA mission called New Horizons will head for Pluto in 2006.

Comet

Our first close-up look at a comet came in 1986 when ESA's Giotto mission made a spectacular flight to Halley's Comet. NASA's Stardust mission flew through the tail of comet Wild 2 in early 2004, catching a sample of debris which it will drop back to Earth in January 2006. The latest comet exploration, mounted by ESA, is called Rosetta. It was launched from Earth in March 2004 and, in 10 years, will land on comet Churyumov-Gerasimenko. The comet lander in this series is modelled on Rosetta's designs. The crew's exploration of the surface draws on all the robotic encounters with comets to date.

Series advisors

Dr David Scott: Apollo 15 commander. Series consultant and lecturer at Space School.

Jean Pierre Haignéré: Former ESA Astronaut and head of their astronaut division. Spent six months on the Mir space station. Series consultant and lecturer at Space School.

Dr Ewald Reinhold: Astronaut with ESA. Advisor on crew reactions to major emergencies. Ewald was on-board the Mir space station with Michael Foale when a fire broke out in 1997.

Dr David Baker: Worked on the Apollo moon-landing programme; author of over 60 books on space. Principal spacecraft designer for the series and lecturer on spacecraft technologies at Space School.

Dr Kevin Fong: Co-Director of the Centre for Aviation, Space and Extreme Environment Medicine, University College London. Principal consultant on extreme environments, medical issues, astronaut welfare and the physiological and psychological effects of space travel. Lecturer at Space School.

Prof Chris Welch: Director of the Aerospace Research Centre, Kingston University. Consultant on spacecraft life support and recycling systems and lecturer at Space School.

Adrian Russell: Head of Concepts for EADS Astrium (European Aeronautic Defence and Space company). Series consultant for the spacecraft design and responsible for approving design concepts, creating technical drawings and providing engineering support.

Prof Michele Dougherty: Space & Atmospheric Physics Group, Imperial College, London. Principal consultant on Jupiter and planetary magnetospheres.

Prof Carl Murray: Professor of Mathematics and Astronomy, Queen Mary and Westerfield College, London. Principal consultant on Saturn and planetary rings.

Dr Charles Cockell: British Antarctic Survey. Series advisor on human planetary expeditions, especially Mars.

Prof Peter Read and Dr Stephen R Lewis: Oxford University. Principle consultants on the Martian atmosphere and weather.

Dr Francisco Diego: CosmicSky Project, University College London. Principal advisor on the Sun.

Dr Andrew Coates: Mullard Space Science Laboratory, University College London. Principal consultant on solar flares and solar radiation doses for crew.

Dr David Hughes: Sheffield University. Principal consultant on cometary bodies.

Prof Alan Penny: SETI Institute, Berkley, California. Principal consultant on optical interferometer telescopes and our Pluto telescope design.

Biographies: Impossible Pictures

Impossible Pictures is an Independent TV Production Company based in the UK and founded in 2002 by Tim Haines and Jasper James, the creators of *Walking With Dinosaurs* and *Walking With Beasts*. Using ground-breaking computer graphics, each series consisted of six 30-minute programmes which were huge international successes. The productions won a number of major television awards, including three BAFTAS and six primetime Emmys, as well as RTS, TRIC, Broadcast and Peabody Awards. *Walking With Dinosaurs* is regarded as the most successful factual programme of all time, with an estimated audience of 375 million viewers.

In 2003, Impossible Pictures produced three CGI-laden documentaries called *Giant Claw*, *Land Of Giants* and *Sea Monsters*, featuring presenter Nigel Marven getting up close and personal with dinosaurs and extinct sea creatures. These programmes also won a BAFTA and an Emmy, with other nominations in the pipeline.

Impossible Pictures are active in entertainment and drama, particularly where there is an opportunity to use their special-effects expertise. Following *The Tamworth Two*, more dramas are currently in development with the BBC as well as a major three-part documentary called *Ocean Odyssey*, which takes a look at life beneath the surface of the ocean. Filming is also underway on a BBC One documentary – *The Story of One* – fronted by Terry Jones.

Biographies: Production

Tim Haines, Executive Producer: Tim Haines was series producer for the ground-breaking *Walking With Dinosaurs*. A qualified zoologist, he joined BBC Science in 1988 and worked on *Tomorrow's World*, *QED* and *Antenna* before founding his own company, Impossible Pictures. Recent projects include *The Giant Claw*, *Land Of Giants* and *Sea Monsters* which, alongside the *Walking With…* productions, won many awards. He was executive producer on major BBC dramas *The Lost World* and *The Tamworth Two* and is currently working on *Ocean Odyssey*.

Christopher Riley, Producer: Chris Riley gained a doctorate in geology and remote sensing from Imperial College in 1995. Since then, he has worked as a science journalist in broadcasting, print and online. From BBC Radio he moved to TV, co-presenting the BBC's 30th anniversary celebrations of Apollo 11. He has produced and directed over 50 films for *Tomorrow's World*, specialising in astronomy and space, and still writes for BBCi's Sci/Tech pages and presents some of BBC Science's astronomy programmes and events. He is co-author of the book of this series with Tim Haines.

Adam Kemp, Executive Producer for the BBC: Adam Kemp is BBC Commissioner for Specialist Factual, Arts and Current Affairs for Independents and Nations. He has initiated many landmark films including *Dunkirk*, *Hawking* and *Pompeii*, and executive produced over 70 factual series from the award-winning *Walking With Dinosaur Specials* and *Elephants – Spy In The Herd* to *Two Fat Ladies* and *Children Of Crime*.

Joe Ahearne, Writer and Director: Renowned television writer and director, Joe Ahearne is used to working on special-effects programmes. Highlights of his career so far include *Strange* (2001/02), *Ultra Violet* (1998) and *This Life* (1987). He is currently working on projects for the BBC and Channel 4.

Jamie Campbell, Art Director: Jamie Campbell's background in film and television work spans over two decades with work on feature films including *Lost In Space*, *Braveheart*, *Muppet Treasure Island* and the *Walking With Dinosaurs* and *Beasts* series. He has vast experience of stop frame animation, motion control, live action shoots, animatronics, special effects and physical effects.

Nick Dance, Director of Photography: Nick Dance has shot a wide variety of film and television productions, both drama and documentary, for the BBC, ITV and Channel 4. He has shot a diverse range of subjects, including gorillas in the Congo, flying with the Red Arrows and diving with the British and US Navy submarine units. His drama credits include *Bad Girls*, *Children Of The New Forest*, *Pompeii – The Last Day* and *Bodies*.

Don Davis, Soundtrack Composer: With his inventive and highly influential scores for the *Matrix* trilogy, Emmy award-winning Don Davis is a key figure in film music history. He has composed for a variety of genres but science fiction, horror and fantasy stories dominate his filmography. His career started in television, where he orchestrated for shows including *Incredible Hulk* and *V*. In 1997, Davis scored his first major feature – the thriller *Bound*. He has also written a number of original concert pieces and is currently composing a new opera.

Framestore CFC: This company is the largest effects facility in Europe, with a track record that includes two Oscars and 11 Emmys awarded for visual effects work. It has worked with Impossible Pictures on all of the *Walking With…* programmes, creating an astonishing array of digital creatures, animations and effects. This series marks a bold leap forward with CG spacecraft, planets and interplanetary phenomena presenting the Framestore CFC team with a whole new array of challenges and opportunities.

Biographies: Actors

Mark Dexter (plays Mission medic John Pearson): RADA-trained Mark is an accomplished stage, television and film actor. Career highlights include playing the young Ralph Nickleby in the film adaptation of *Nicholas Nickleby*, TV appearances in *Spooks* and *Monarch Of The Glen*, and theatre roles in Sam Mendes's *The Glass Menagerie* and Trevor Nunn's *Not About Nightingales*.

Lourdes Faberes (plays Flight Dynamics Officer Isabel Liu): Originally from the Philippines, Lourdes trained at the Central School of Speech and Drama. Her acting credits include the films *The Escort* and *The Visitors*; and television appearances include *Manchild* and *Dr Terrible And The House Of Horrible*. She has performed in the West End production of *The Graduate* and is currently in the Young Vic's *Cruel And Tender*.

Michelle Joseph (plays Mission scientist Nina Sulman): Michelle trained at the Rose Bruford College of Speech & Drama and has acted extensively on stage, television and film. Her credits include: for the BBC – *Messiah III*, *Strange*, *In Deep*, *EastEnders* and *As Time Goes By*; for Channel 4 – *Roy Dance Is Dead* and *Without Walls*; and for ITV – *A Touch Of Frost* and *The Bill*.

Rad Lazar (plays Flight Engineer Yvan Grigorev): Rad was a rising star in Yugoslavia when he fell foul of the Milosevic regime. Dramatically escaping an attempt on his life, he is now permanently settled in the UK as a British citizen. He is rebuilding his career with notable appearances in *The Bill*, *Dalziel & Pascoe* and *Prime Suspect*.

Hélèn Mahieu (plays Chief Flight Surgeon Claire Granier): Hélèn appeared in *Guesthouse Paradiso*, playing the lead character Gina Carbonara, and as Anne in *Plume de Sang*. On TV, she is best known for the Renault Clio advert – *Size Matters*. Hélèn lives in Paris.

Martin McDougall (plays Commander Tom Kirby): Martin was born in Edinburgh but grew up in New Jersey. He returned to Great Britain to study acting at Webber Douglas. Career highlights include writing and performing in his own play, *Watching The Sand From The Sea* and roles in *The Cambridge Spies* and *High Octane*. He has just finished filming *The Intimidation Game*.

Joanne McQuinn (plays Mission scientist Zoe Lessard): Joanne was born in London but grew up in Canada. At 17, she was one of the youngest students to be accepted into the National Theatre School of Canada in Montreal. Joanne has numerous roles in theatre, radio drama, television and independent film, including *Our Friends In The North* and *Suckerface*.

John Schwab (plays Capcom Larry Conrad): John has been a member of the Reduced Shakespeare Company for the last five years, with further stage appearances in *Elvis* and *Buddy*. Television credits include *Hotel* and *My Dad's The Prime Minister*. He has also performed in many radio plays for BBC World Service and Radio 4 including *The Grapes Of Wrath* and *Life Story*.

Colin Stinton (plays Flight Fred Duncan): Born and raised in Canada, Colin is now permanently based in London. He has worked extensively as an actor in films such as *Tomorrow Never Dies*, *The Hours*, *Proof* and *The Jacket*. His television credits include *A Year In Provence*, *Jonathan Creek* and *Frightmares*. He is currently touring in *Man And Boy*.

Mark Tandy (plays Chief Scientist Alex Lloyd): Mark has had a long and varied career in theatre, television and film, from seasons with The Royal Shakespeare Company to television dramas such as *Inspector Morse*, *A Touch Of Frost* and the award-winning *Shackleton*, plus films including *Howard's End* and *Mrs Dalloway*. He will soon be seen in *Bridget Jones: Edge Of Reason*.