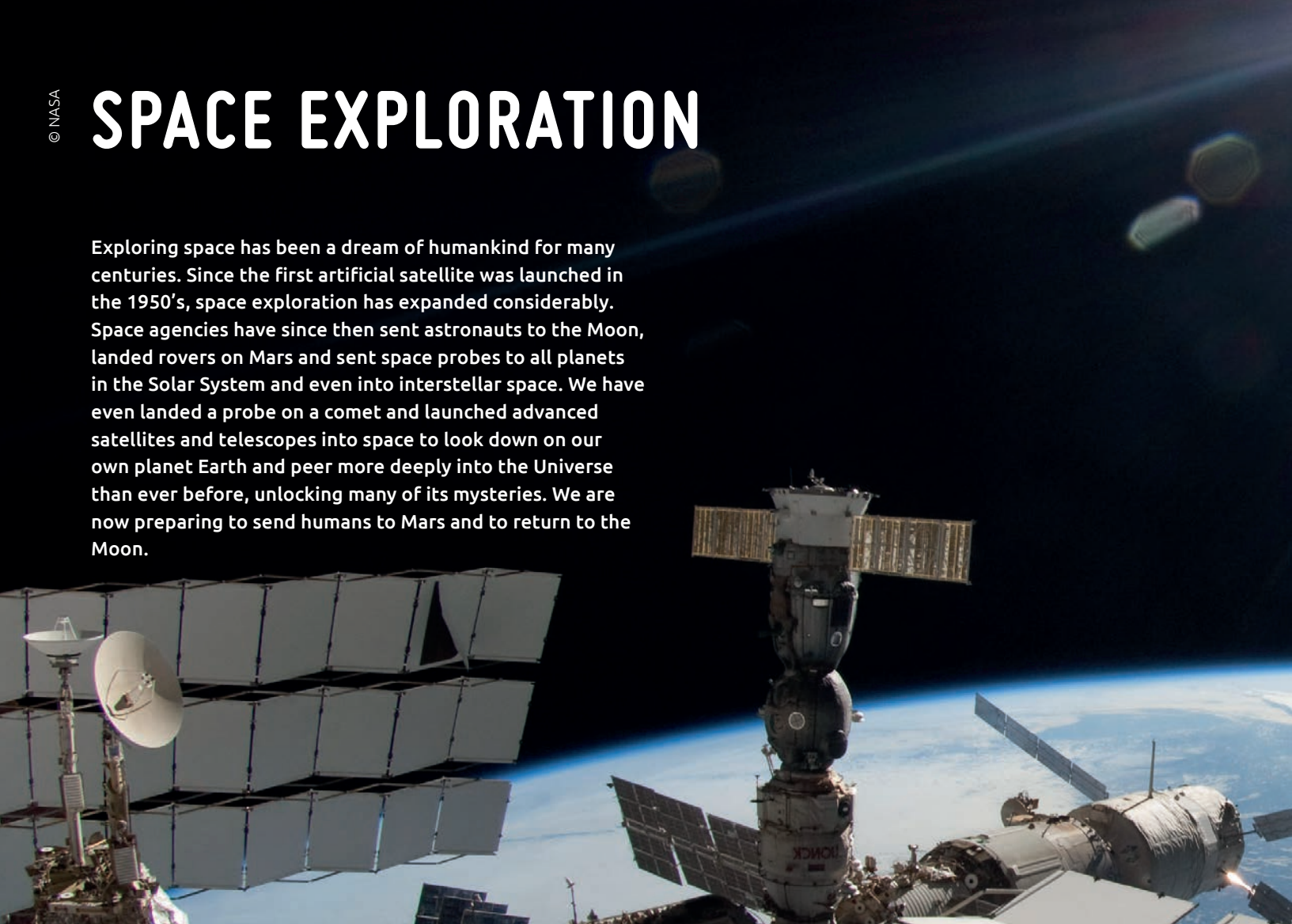
SPACE CAREERS

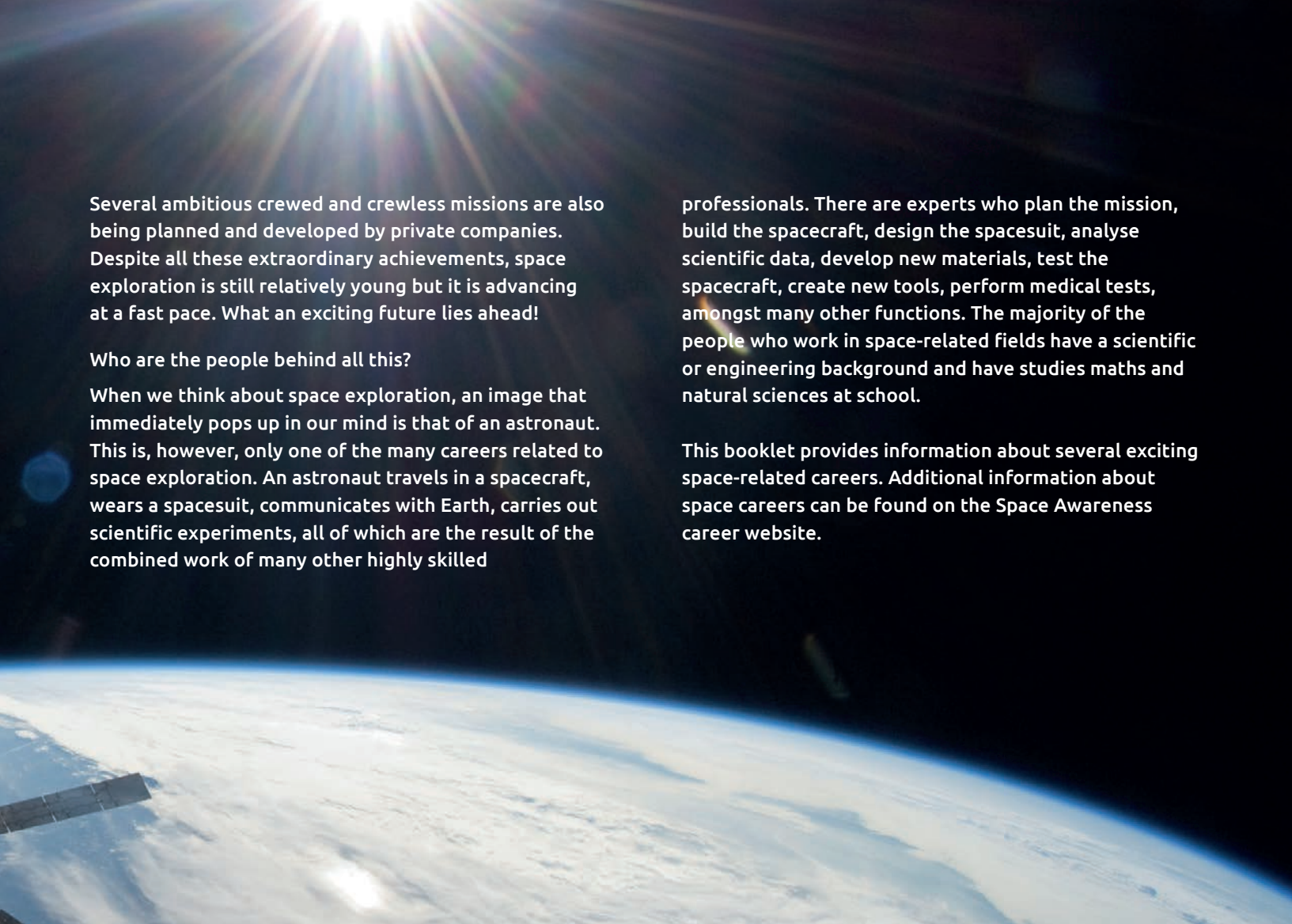
SPACE awareness

INSPIRING A NEW GENERATION OF SPACE EXPLORERS

SPACE EXPLORATION

Exploring space has been a dream of humankind for many centuries. Since the first artificial satellite was launched in the 1950's, space exploration has expanded considerably. Space agencies have since then sent astronauts to the Moon, landed rovers on Mars and sent space probes to all planets in the Solar System and even into interstellar space. We have even landed a probe on a comet and launched advanced satellites and telescopes into space to look down on our own planet Earth and peer more deeply into the Universe than ever before, unlocking many of its mysteries. We are now preparing to send humans to Mars and to return to the Moon.





Several ambitious crewed and crewless missions are also being planned and developed by private companies. Despite all these extraordinary achievements, space exploration is still relatively young but it is advancing at a fast pace. What an exciting future lies ahead!

Who are the people behind all this?

When we think about space exploration, an image that immediately pops up in our mind is that of an astronaut. This is, however, only one of the many careers related to space exploration. An astronaut travels in a spacecraft, wears a spacesuit, communicates with Earth, carries out scientific experiments, all of which are the result of the combined work of many other highly skilled professionals. There are experts who plan the mission, build the spacecraft, design the spacesuit, analyse scientific data, develop new materials, test the spacecraft, create new tools, perform medical tests, amongst many other functions. The majority of the people who work in space-related fields have a scientific or engineering background and have studies maths and natural sciences at school.

This booklet provides information about several exciting space-related careers. Additional information about space careers can be found on the Space Awareness career website.

SPACE CAREERS

ASTRONAUT

Nowadays, astronauts work aboard the International Space Station (ISS), a research facility in space, where they carry out scientific experiments in a microgravity environment.
Astronauts need to complete a very intensive training and evaluation period before they are allowed to go into space. This usually lasts for 2 years. Candidate astronauts are required to have a university degree in Natural Sciences, Engineering or Medicine. Their height should be between 1.53 - 1.90 m, and they should have an excellent vision and good physical and psychological health. Experience as an aircraft pilot is usually an advantage. Their training and evaluation phase includes education in robotics, ISS systems, extravehicular activity skills and Russian language. So far only about 560 astronauts have been selected from many thousands of candidates worldwide. During each mission, astronauts have a specific role: they can be the commander, the pilot or a mission specialist. They conduct scientific experiments, perform extravehicular activities such as repairing instruments, using remote manipulator systems and carry out any tasks communicated to them by the ground station.

"There is still so much beauty on Earth to be observed from space."

Thomas Pesquet • ESA Astronaut

SCIENTISTS

METEOROLOGISTS

study and forecast the Earth's atmospheric phenomena. Before the launch of any spacecraft, an accurate weather prediction is very important to ensure a safe and successful the mission. Meteorologists need to make sure that during the launch window, the winds are not too strong, there are no thunderstorms within a safety radius, the layer of clouds is not too thick, does not contain rain and is neither too hot nor too cold.

EARTH OBSERVATION SCIENTISTS

gather images and data from the Earth´s surface and atmosphere made with cameras and other instruments placed on a satellite orbiting the Earth, or on an aircraft flying over a particular region, or even on a drone flying over your backyard. They use the information collected to learn more about the weather, the damage caused to a forest in a storm, the area flooded after a strong rainfall event, the area of a country planted with different crops, the temperature of the water in the sea and many more phenomena. The data that they use essentially give us a bird´s eye view of the Earth.

ASTROPHYSICISTS

observe the Universe with the goal of understanding how it formed, how it evolved to become what it is today and what it will be like in the future. To do this, astrophysicists study planets, stars, nebulae, galaxies, clusters of galaxies, etc. They use telescopes both on Earth and in space, many of which are sensitive to frequencies of the electromagnetic spectrum that are invisible to our eyes, like microwaves, radio, ultraviolet, X-rays and gamma-rays. They also develop physical theories and build computer simulations to model and help us understand phenomena in the Universe.

PLASMA PHYSICISTS

study plasmas, which are a state of matter that occurs when a gas is so hot that all its atoms are split into electrons and ions, which can move independently of each other. Plasma is created, for example, when a spacecraft travelling at several kilometres per second enters the atmospheric boundary of a planet or Moon. One of the aims of plasma physicists is to obtain a detailed understanding of the physics of these atmospheric entry plasmas. They thus work together with engineers and scientists in the design of spacecrafts to ensure their structural integrity.

ASTROGEOLOGISTS

study the geological evolution of our 'rocky' companions in the Solar System, seeking to understand and reconstruct the evolution of their interiors and surfaces. Because it is not yet possible to carry out fieldwork on bodies such as Mars, Titan or asteroids, their geologic evolution is mainly studied by analysing observations from spacecrafts together with data gathered by robotic missions on their surface.

PROJECT SCIENTISTS

are scientists whose role is to monitor all phases of the project and research and develop the scientific input necessary for the space project. The project scientist is also in charge of translating the scientific needs of a mission into technical requirements for engineers.

SPACE WEATHER SCIENTISTS

monitor the "weather" within the Solar System, particularly around Earth, as it varies due to the interaction of the solar wind with the Earth's magnetic field. They track the effect of solar eruptions, disturbances in the solar wind, changes in the magnetic field and the incidence of cosmic rays that can all affect spacecrafts. All electronic devices in a spacecraft are sensitive to electric charges and it is crucial to observe the conditions of space weather to prevent failure due to radiation damage and electrical charging of the spacecraft.

MATHEMATICIANS

use mathematics and statistics to solve scientific, engineering and business problems that come up during a space mission. They might create models to improve the aerodynamics of spacecrafts, implement mathematical functions to optimise the performance of algorithms for analysing images, aspects of instrumentation, and many other applications.

ASTROBIOLOGIST

An astrobiologist studies the possibility that life exists beyond the Earth. Astrobiologists try to understand how life is formed and how life can survive in many different types of environments. This often involves the study of life in extreme conditions right here on Earth. They observe various planets and moons to see if conditions there could support life.

Some astrobiologists are involved in projects that search for radio signals from intelligent life in the Universe, while others look for places where the simplest forms of life may exist. An astrobiologist is usually an expert in biology as well as in astronomy.

In order to find out if life can exist in other worlds, an astrobiologist spends a lot of time in laboratories, testing and recording the lifecycle of bacteria that can survive in extreme conditions, and even looking at fossils of the earliest life forms.

" Being an astrobiologist is the most exciting job in the world: I analyse extra-terrestrial rocks named meteorites and try to discover alien life in our Solar System"

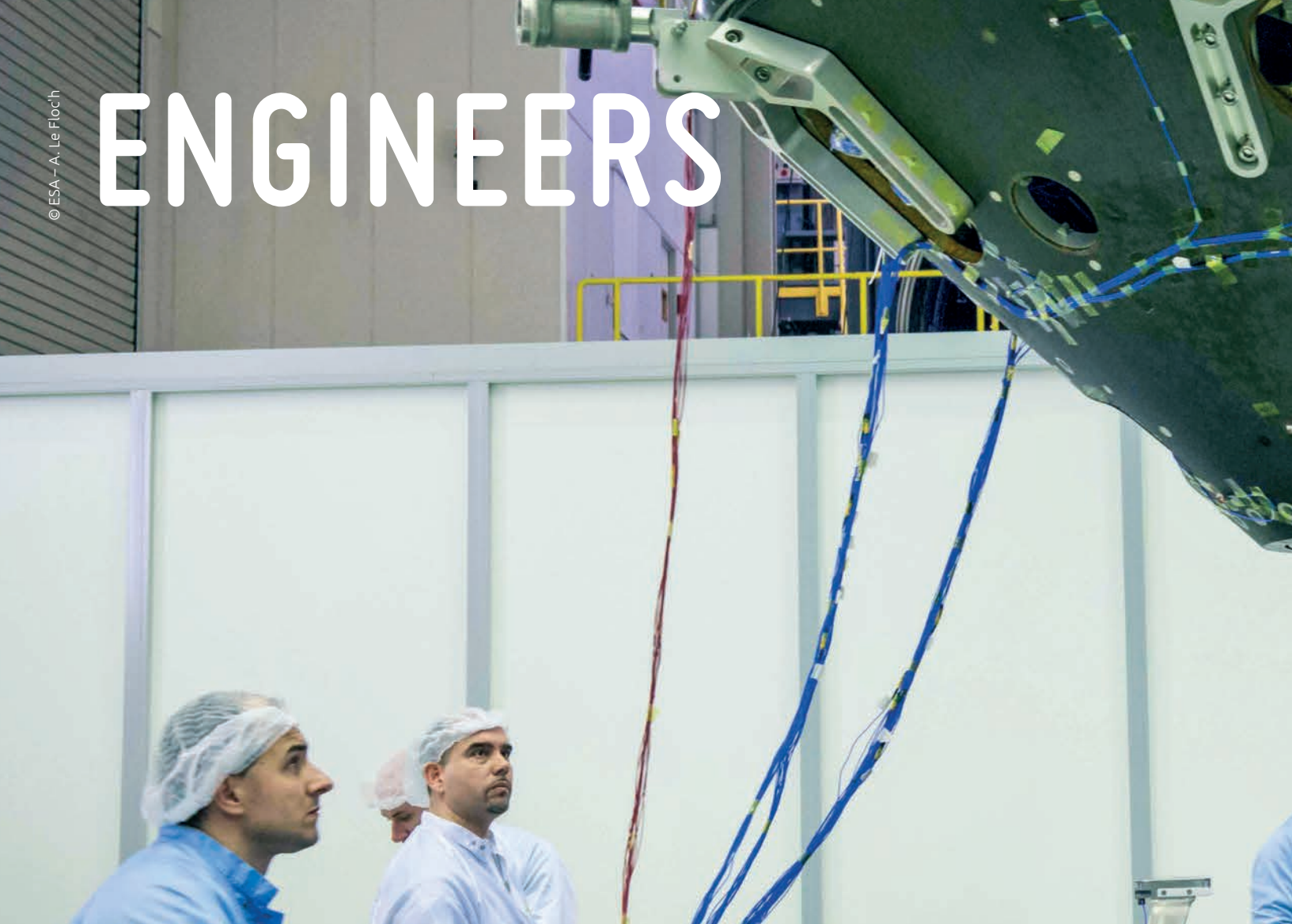
Zita Martins • Astrobiologist at Department of Earth Science and Engineering, Imperial College London

ARCHAEOASTRONOMER

Archaeoastronomy is the study of how people have understood, conceptualised and used the phenomena in the sky and what role the sky played in their cultures. They do this by analysing their material remains. According to historical and ethnographic records, most - if not all - societies have looked up at the sky and related to it. The stories, myths, art, religious beliefs, rituals and symbolisms of many cultures are associated with the Sun, Moon, stars and planets. However, when a study extends further back into prehistory (before writing was established), researchers must rely on the remains and ruins left behind. In this case, the research is based on the archaeological record, which is used to reveal an ancient society's notion of the location and movement of objects in the nightsky.Archaeoastronomy, therefore, focuses on the material evidence present in the archaeological record. For instance, archaeoastronomers can recognise whether particular structures (houses or monuments) were intentionally built in such a way to capture sunlight on particularly important days of the year. Archaeoastronomy, therefore, is one more element that can help us make sense of and understand past societies, their beliefs and worldviews.

" I love trying to see the universe as prehistoric people would have seen it."

Fábio Silva • Lecturer in the Sophia Centre at the University of Wales Trinity Saint David Lampeter

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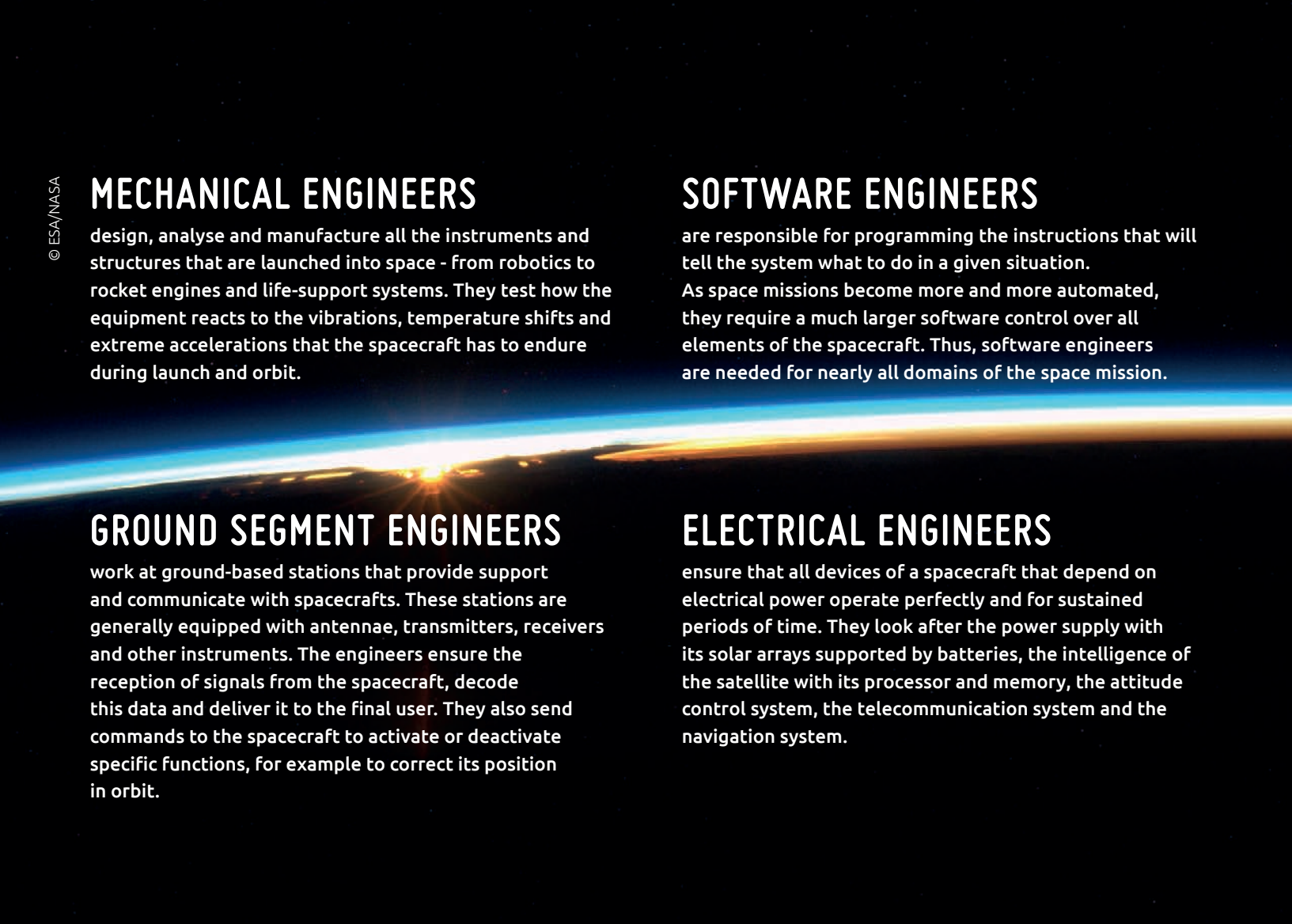


MECHANICAL ENGINEERS

design, analyse and manufacture all the instruments and structures that are launched into space - from robotics to rocket engines and life-support systems. They test how the equipment reacts to the vibrations, temperature shifts and extreme accelerations that the spacecraft has to endure during launch and orbit.

SOFTWARE ENGINEERS

are responsible for programming the instructions that will tell the system what to do in a given situation.
As space missions become more and more automated, they require a much larger software control over all elements of the spacecraft. Thus, software engineers are needed for nearly all domains of the space mission.

GROUND SEGMENT ENGINEERS

work at ground-based stations that provide support and communicate with spacecrafts. These stations are generally equipped with antennae, transmitters, receivers and other instruments. The engineers ensure the reception of signals from the spacecraft, decode this data and deliver it to the final user. They also send commands to the spacecraft to activate or deactivate specific functions, for example to correct its position in orbit.

ELECTRICAL ENGINEERS

ensure that all devices of a spacecraft that depend on electrical power operate perfectly and for sustained periods of time. They look after the power supply with its solar arrays supported by batteries, the intelligence of the satellite with its processor and memory, the attitude control system, the telecommunication system and the navigation system.

PROPULSION ENGINEERS

are responsible for the chemical rocket propulsion systems of spacecrafts. Launchers, satellites, probes and space vehicles require specific fuels and engines to propel them into space, place them into orbit, or, in the case of deep space missions, to provide energy for their interplanetary flight. They develop and design the most suited propulsion system for the spacecraft.

AEROSPACE ENGINEERS

design, develop, manufacture and test spacecrafts, satellites and other aerospace products.
They develop new technologies for the structural design of the spacecraft, guidance and navigation, control, instrumentation, communication, robotics, and propulsion of the spacecraft.

CHEMICAL ENGINEERS

work on many aspects of space missions. They can develop better batteries, more efficient fuels, better radiation shielding, etc. Chemical engineers also do research on new sources of fuel such as hydrogen cells, bio-refineries, algae factories and fusion reactions, which can be applied to space technology in the future.

PRODUCT ASSURANCE AND SAFETY ENGINEERS

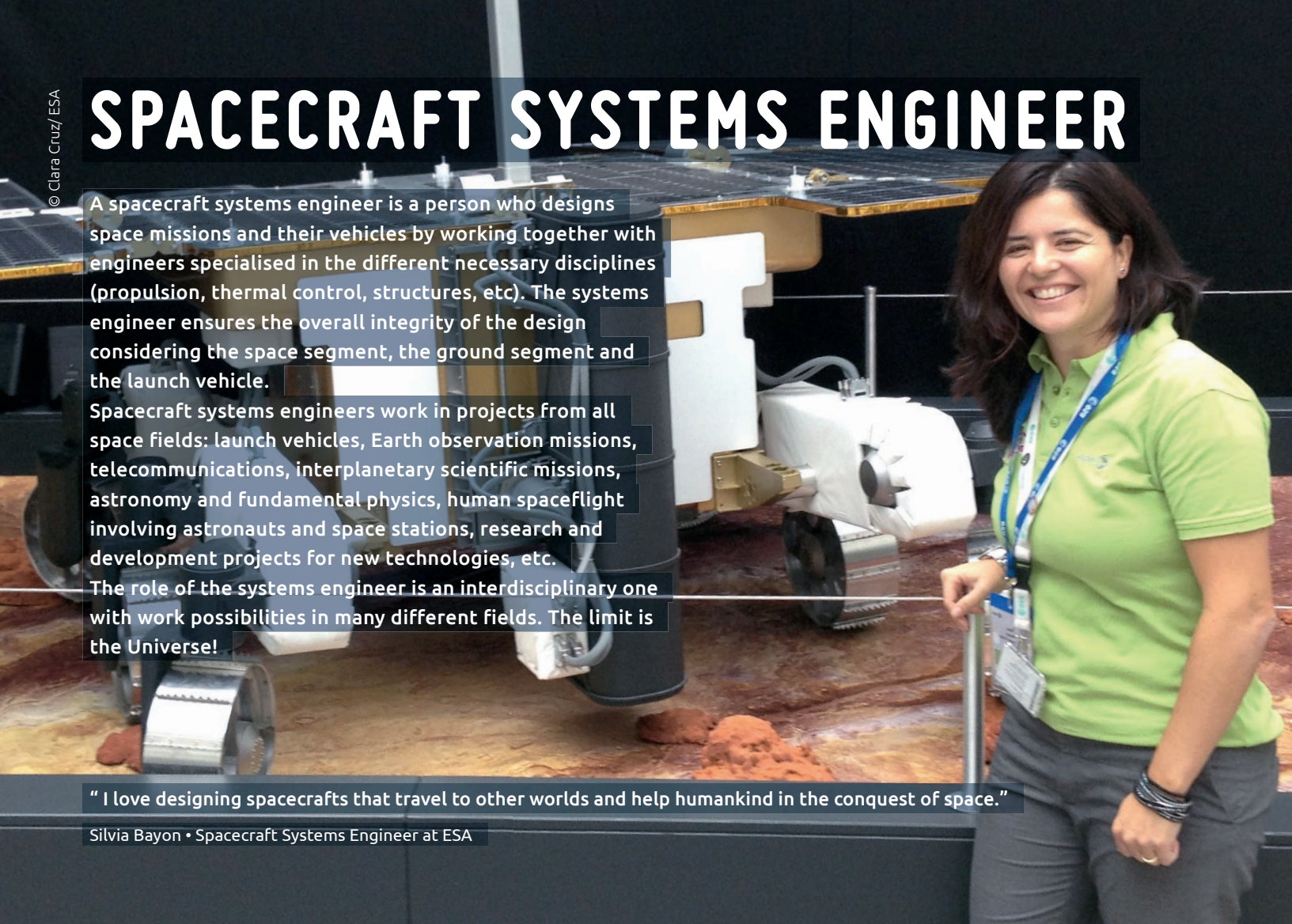
try to ensure that all safety measures are rigorously taken to prevent anything going wrong in space.
They make sure that all materials, mechanical parts and electrical components used are the most reliable available. They test them against failure to make sure they are in optimal condition and will work well throughout the whole duration of the space mission.

SPACECRAFT SYSTEMS ENGINEER

A spacecraft systems engineer is a person who designs space missions and their vehicles by working together with engineers specialised in the different necessary disciplines (propulsion, thermal control, structures, etc). The systems engineer ensures the overall integrity of the design considering the space segment, the ground segment and the launch vehicle.

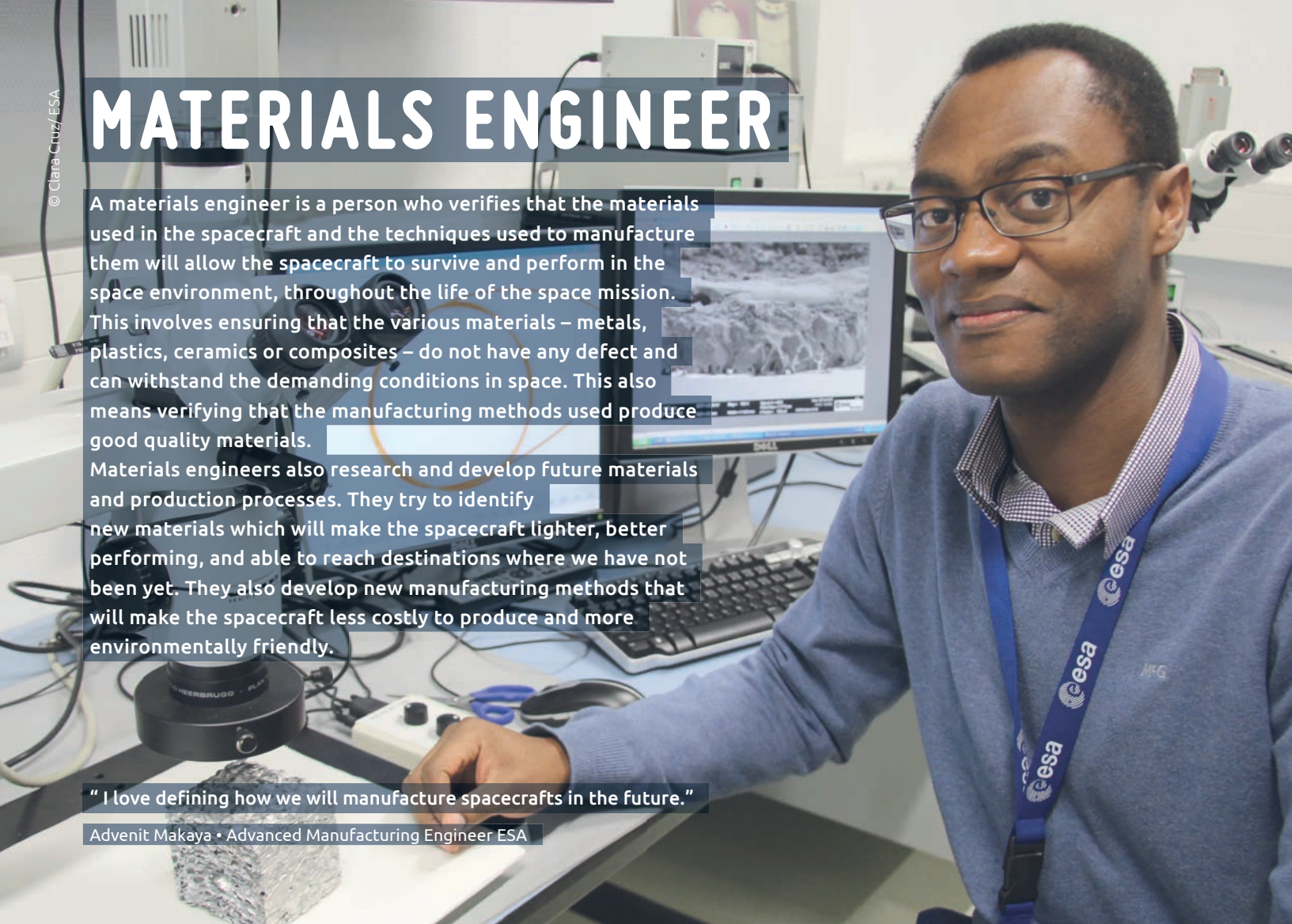
Spacecraft systems engineers work in projects from all space fields: launch vehicles, Earth observation missions, telecommunications, interplanetary scientific missions, astronomy and fundamental physics, human spaceflight involving astronauts and space stations, research and development projects for new technologies, etc.

The role of the systems engineer is an interdisciplinary one with work possibilities in many different fields. The limit is the Universe!



" I love designing spacecrafts that travel to other worlds and help humankind in the conquest of space."

Silvia Bayon • Spacecraft Systems Engineer at ESA



MATERIALS ENGINEER

A materials engineer is a person who verifies that the materials used in the spacecraft and the techniques used to manufacture them will allow the spacecraft to survive and perform in the space environment, throughout the life of the space mission. This involves ensuring that the various materials – metals, plastics, ceramics or composites – do not have any defect and can withstand the demanding conditions in space. This also means verifying that the manufacturing methods used produce good quality materials.

Materials engineers also research and develop future materials and production processes. They try to identify new materials which will make the spacecraft lighter, better performing, and able to reach destinations where we have not been yet. They also develop new manufacturing methods that will make the spacecraft less costly to produce and more environmentally friendly.

“ I love defining how we will manufacture spacecrafts in the future.”

Advenit Makaya • Advanced Manufacturing Engineer ESA

OTHER PROFILES

NUTRITIONISTS

are in charge of making sure that astronauts' diet is balanced and nutritious and attends to the dietary requirements of each astronaut. Due to the lack of gravity, there are some food restrictions in space. Food needs to be conserved differently than on Earth and some flavours also taste different, so astronauts' diethas to be adapted to those conditions.

GRAPHIC DESIGNERS

work on the graphic illustrations of space missions for the public and media. They also produce infographics to translate complex ideas into simple graphics and thereby help scientists and engineers communicate their ideas to the public. Their work could be in the form of sketches, scale models, animations, infographics, and various other products.

SPACE EDUCATORS

are concerned with spreading knowledge and raising awareness about space with the general public.
Space educators use the vast knowledge generated in the space field to attract students to science and technology, to improve their competences in these fields and stimulate them to pursue a scientific or technical career in the future.

PROJECT MANAGERS

are responsible for the whole management of a space project. They define the project's strategy, develop a plan of action to achieve each goal, assign tasks to teams and follow-up on all the implementation processes.

MEDICAL DOCTORS

test astronauts' health during training and monitor it in space. The hazardous conditions of space have a strong impact on the body, such as muscle atrophy, loss of bone mass and blood volume, slower wound healing and immune system weaknesses. All of these require a careful monitoring and counter-measures to keep astronauts fit and healthy.

SPACE WRITERS

are writers, often freelancers, with a scientific background, who specialise in space-related topics.
They write articles for magazines, newspapers, websites and even film scripts and science fiction books.
They may write about a recent discovery, describe upcoming missions, talk about the social aspects
of space exploration, provide a breakdown of technicalities for the general public, etc.

ASTRONAUT COSTUME DESIGNERS

develop the astronauts' costumes, taking into account the various requirements of space. They work with textiles that are being developed specifically for space. Costume designers use cutting-edge technologies to satisfy the requirements of both safety and comfort for an astronaut and produce unique and individually tailored costumes.

ACOUSTIC TECHNICIANS

test the resistance of satellites and spacecrafts to the loud noise produced during launch. The vibrations produced by the launch engines and by the airflow passing along the spacecraft produce such strong pressure levels that the spacecraft can be destroyed if it is not properly built. Acoustic technicians use acoustic chambers to test and improve the spacecraft's design to withstand the launching.

SPACE LAWYER

Space Lawyers make sure that everything planned by a space mission is in accordance with the regulations of international space law and is approved by the countries involved. They monitor activity of their companies or government organisations to ensure that everything is in accordance with the regulations written by the United Nations and the various space treaties.
Since space exploration is a relatively new field evolving at a fast pace, new legal challenges appear constantly. Space law professionals have recently became in high demand. In a few years we may start to do asteroid mining and attempt to colonise Mars. These activities will give rise to many legal questions for the first time, for which regulations will need to be developed.

" Being a space lawyer means looking into the future of humanity in space and promoting innovative regulation; both truly fascinating"

Neta Palkovitz - Space Lawyer at Innovative Solutions In Space B.V. (ISIS)

SPACE PSYCHOLOGIST

Psychology deals with understanding the mental processes that drive human beings, and how they relate with each other and their environment.
It attempts to explain how psychological characteristics such as memory, emotions, and motivation work and develop.
Living in space can seem exciting, but astronauts (and future space settlers) often experience a series of stressors (e.g. due to conflict and isolation) that might have an impact on how they think and feel while in space.
Such considerations motivate psychologists to learn about human mental processes during space-related activities, and understand how living in space can influences an astronaut's mood, wellbeing and their performance. Furthermore, psychologists study how space crews on board a spaceship or the International Space Station can best maintain successful collaborations with mission control personnel over long periods.

" To be a space psychologist is to prepare those in the space industry to develop a strong mental health, and outstanding teamwork capacity."

Pedro Marques Quinteiro • Postdoctoral fellow at William James Center for Research (ISPA-IU)

SPACE CURIOSITIES

HOW FAR AWAY IS SPACE?

The boundary between the Earth's atmosphere and outer space lies at an altitude of ~100 km, and it is called the "Karman Line". This is officially where space begins.
If we could drive upwards in our car, it would only take us about an hour to reach space.

ARE WE TALLER IN SPACE?

Because of the lack of gravity in space, astronauts are not pulled down and their spine straightens up. This causes them to become up to 3% taller while living in space. That means that a 1.8m tall astronaut could grow by up to 5 cm in space.
The designers of astronaut suits need to take this growth into account. However, astronauts do not need to worry about buying new clothes since after they return to Earth, gravity will make their spines return to their normal size.

IS THE MOON MOVING AWAY FROM US?

The Moon is indeed moving away from the Earth at a rate of 3.8 cm per year. This is mainly because of tidal forces from the Earth acting on it. Scientists believe that the Moon was formed when a proto-planet about the size of Mars collided with the Earth about 4.5 billion years ago. The remains left over from the impact then formed the Moon.

HOW MUCH DOES A SPACESUIT WEIGHT?

There are different kinds of spacesuits. A spacesuit for use outside the International Space Station nowadays weighs around 50 kg, whereas in the past some suits weighed up to 140 kg. The spacesuit is made of several layers and it includes oxygen and water supply and shielding against radiation and micrometeorites. They also contain pressure and temperature control systems and insulation against extreme temperature variations.

WHAT DO ASTRONAUTS AND FIREMEN HAVE IN COMMON?

Firemen use a lightweight costume made of fabric that is resistant to fire and protects them from heat. Such fabrics were originally developed to protect astronauts.

WHAT IS THE RELATION BETWEEN LUNAR BOOTS AND TRAINERS?

The reason why trainers are so comfortable is because of the way they were designed, particularly due to the shock absorbers that are used in the midsole.
This technology was originally developed for boots worn by astronauts on the Moon.

Check out more space curiosities on www.spacescoop.org

WHAT DOES A JOYSTICK HAVE TO DO WITH THE MOON?

The joystick technology was originally created by NASA scientists to help astronauts command the lunar vehicle (Rover Lunar Apollo) on the Moon.

CAN WE HEAR IN SPACE?

The sounds we hear on Earth are the result of vibrations that are transmitted through the air and reach our ears, where our eardrums detect them. However, these vibrations only propagate through matter such as air and liquids. In outer space there are almost no particles, so sound does not propagate. Thus, you would not hear the explosion of a nearby spaceship as is often portrayed in films! However, inside a spacecraft, where there is air, sound propagates just as on Earth.

CAREER PATHS IN SPACE

WHO ARE THE SPACE EMPLOYERS?

SPACE AGENCIES

Many countries have a national space agency. These agencies carry out exploration missions, human space flights, Earth observation missions, as well as research in many areas.

COMPANIES AND INDUSTRY

Companies in the space industry manufacture components for spacecrafts, satellites, rockets, optical systems and many other devices used in space exploration.

UNIVERSITIES, RESEARCH CENTRES AND MUSEUMS

These are the organisations where most research that directly or indirectly benefits space exploration is done. This includes fields as varied as astrophysics, biology, psychology, physiology, geology and mathematics.

BREAKDOWN OF JOBS AT ESA

7%	SCIENTISTS & ASTRONAUTS
12%	MANAGERS
16%	MANAGEMENT SUPPORT PROFESSIONALS
20%	ADMIN & TECHNICAL SERVICES STAFF
45%	ENGINEERS & ANALYSTS

EUROPEAN SPACE AGENCY

The European Space Agency (ESA) is one of the main employers in the Europese space sector. It currently employs about 2,200 people at various locations worldwide.

ESA is an international organisation with 22 Member States and two associate states. ESA's mission is to find out more about the Earth, its immediate space environment, our Solar System and the Universe, as well as to develop satellite-based technologies and services, and to promote European industries. ESA also works closely with space organisations outside Europe.

The majority of jobs in ESA are within the engineering and scientific disciplines, but there is also a significant number of administrative and technical staff as well as management support professionals.

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ESA YOUNG GRADUATE TRAINEE PROGRAMME

ESA has a Young Graduate Trainee Programme and student internships for recently qualified graduates with a Masters degree or equivalent. This is a one-year training programme designed to give young graduates valuable experience in the development and operation of space missions. Graduate Trainees take on a responsible role in supporting a project, and benefit from the expertise of an ESA mentor. More information can be found under the Young Graduate Trainee Programme:
www.esa.int/About_Us/Careers_at_ESA/Young_Graduate_Trainees

YOUNG GRADUATE TRAINEE

Justyna Barys is a graduate trainee working at ESA's technical centre. She works on the Micro-Ecological Life Support System Alternative ("MELiSSA") project to develop closed-loop life support for future deep-space expeditions: according to Justyna 'We are used to obtain oxygen, water and food from the Earth's ecosystem. It would be ideal if we could carry the Earth's ecosystem with us when we explore the Solar System. Unfortunately, this is not possible. Instead, the MELiSSA approach is inspired by the principle of a closed 'aquatic' lake ecosystem. The carbon dioxide and waste products are progressively processed to allow the culture of plants and algae. These plants and algae will then provide food, oxygen and water purification. To grow plants, we need nitrogen. Human urine is a good source of nitrogen, but doesn't contain it in the form that plants need – nitrates. There are bacteria, originally taken from soil, that perform this conversion job, so I've been attempting to cultivate them and study how they grow.'

" I'd always been interested in astronomy and space and regularly visited the NASA and ESA websites. I didn't think the Young Graduate Trainee vacancy was something for me at first, but it turned out to be very interesting and matched the combination of engineering and microbiology in my background."

Justina Barys

ESA ACADEMY

ESA offers university students up to PhD level specialised training and hands-on projects opportunities through the ESA Academy education programme.
This ranges from training courses in space-related disciplines to small satellites projects and scientific experiments, all under the supervision of professional space experts. The programme helps students embark on a career in the space sector.

More information about the ESA Academy can be found at:
www.esa.int/Education/ESA_Academy

SPACE awareness

THE SPACE AWARENESS PROJECT USES THE EXCITING WORLD OF SPACE TO ENGAGE YOUNG PEOPLE IN SCIENCE AND TECHNOLOGY AND STIMULATE THEIR SENSE OF EUROPEAN AND GLOBAL CITIZENSHIP. SPACE AWARENESS SHOWS CHILDREN AND TEENAGERS THE RELEVANCE OF SPACE SCIENCE AND TECHNOLOGY TOTHEIR LIVES AND THE CAREER OPPORTUNITIES OFFERED BY THE SPACE SECTOR.

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CIÊNCIA VIVA

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European Schoolnet

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WWW.SPACE-AWARENESS.ORG