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Introduction

Approximately every six months, a Soyuz rocket is launched to carry a new Soyuz capsule to the International Space Station (ISS), to replace the one that has been docked there since the last visit. This regular schedule is dictated by the fact that the ISS's current crew of three relies on the docked Soyuz capsule as a lifeboat should they have to leave the Station unexpectedly. Since the start of the Station's build-up, there have been four Soyuz-capsule exchanges. Each Soyuz flight brings up an additional crew of three, who stay on board for 8 days to perform scientific research.

Because there are presently only three permanent crew members on the ISS, instead of the intended seven, ESA has been forced to look for additional flight opportunities. Negotiations with the Russian Space Agency resulted in a cooperation agreement that enables ESA astronauts to fly in the Soyuz capsule as 'flight engineers' and then perform scientific experiments whilst aboard the Space Station.

Following similar initiatives by France and Italy, the Belgian Federal Department for Scientific, Technical and Cultural Affairs (OSTC) decided to fund such a Soyuz mission within this framework for October 2002. An extensive scientific programme was developed and prepared by ESA and OSTC. Belgian ESA astronaut Frank De Winne was appointed to perform these experiments and to fly to the ISS as Soyuz flight engineer. He had the additional privilege of being on the maiden flight of the latest model of the Soyuz spacecraft, known as Soyuz-TMA.

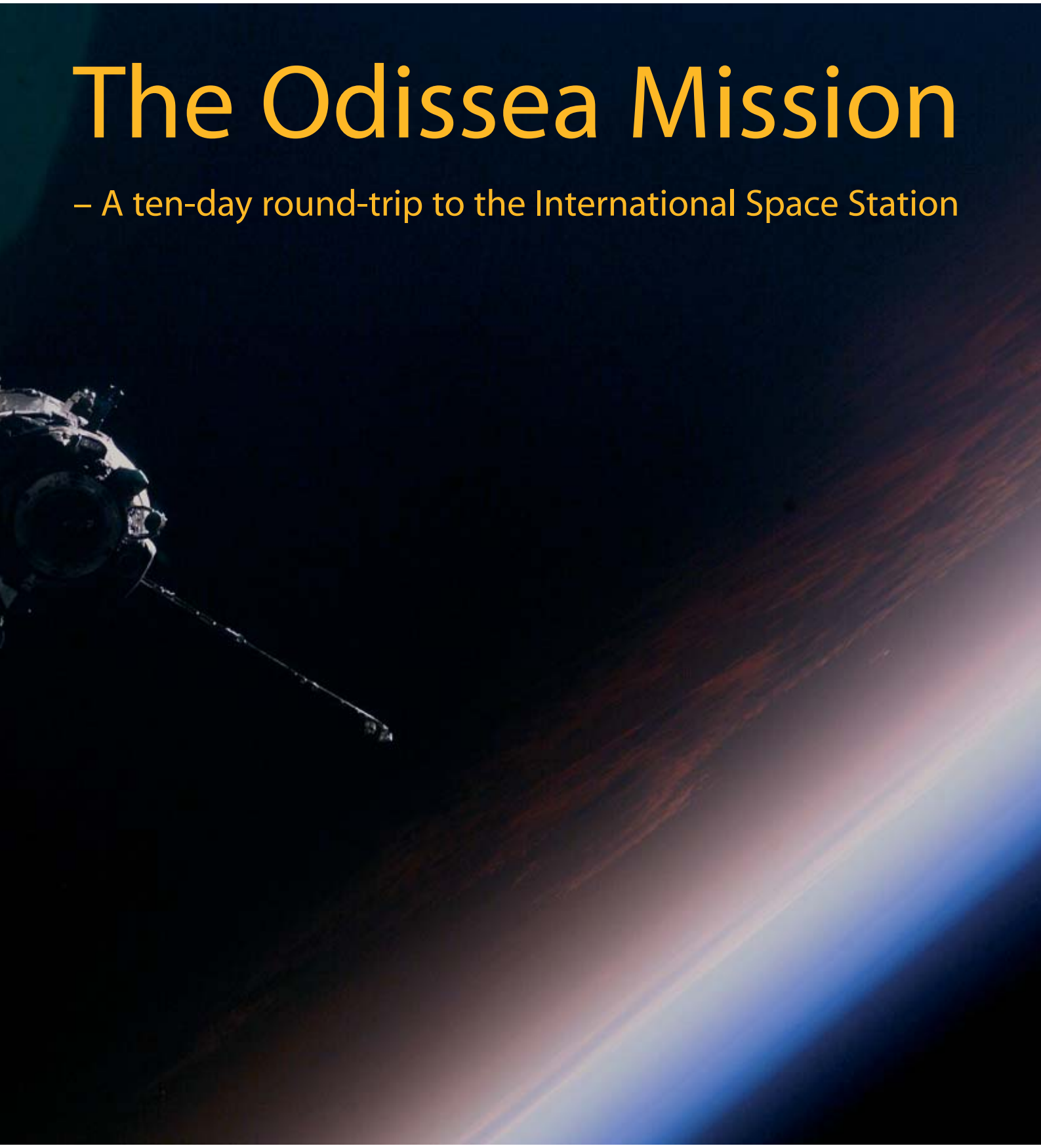
The mission also had some other firsts for an ESA astronaut, namely: the use of the ESA-developed Microgravity Science Glovebox, the fact that Frank was to work in both the US and Russian segments of the ISS, and the novelty that he was to fly in two different models of the Soyuz capsule.

After one and a half years of training and experiment preparation, the Soyuz lifted off on 30 October 2002, with commander Sergei Zaletin (the last commander of the Mir space station), with Frank as flight engineer in the left-hand seat and with flight engineer Yuri Lonchakov (reserve commander) in the right-hand seat. The two-day trip to the Station went according to plan and the eight-day programme of experiments conducted on board was a great success.

On 10 November, the visiting crew returned in the Soyuz TM-34 capsule that had carried the crew that included Italian ESA astronaut Roberto Vittori to the ISS in April 2002. It made a very special night landing in Kazakhstan. Frank subsequently 'continued' his mission through extensive baseline data collection for the demanding set of medical experiments that he had conducted in orbit.

The Odissea Mission

– A ten-day round-trip to the International Space Station



ESA astronaut Frank De Winne checks out his Sokol space suit

Getting Ready

Frank's intensive training for the mission had begun in August 2001, doing his initial training together with Roberto Vittori. Besides the many hours spent in the classroom learning about all the different aspects of the Soyuz and the ISS, there was also survival training in the Black Sea and in winter conditions, for the unlikely event that the landing would not be in the Kazakh steppes. They also did weightlessness training in an Ilyushin-76 aircraft, as well as riding in a human centrifuge to prepare them for the g-forces that they would experience during launch and landing. One of the most demanding parts of the training was mastering the Russian language!

As already mentioned, the crew for the Belgian flight had to master both the old Soyuz TM capsule in which they would be returning to Earth, as well as the brand new Soyuz TMA. The TMA (the 'A' stands for anthropometric) differs from the previous TM version in several aspects, not least of which is the greater space available for the cosmonauts, allowing taller cosmonauts to fit into the capsule, and the fact that many of the real buttons in the older version have now been replaced by virtual functions on displays.

Eight months into the training programme, the practical training in the Soyuz simulator began. The crew spent long hours, many in their space suits, training in the simulator in order to prepare them for all kinds of events and eventualities. The two ESA flight engineers were in good hands with the Russian trainers at the Yuri Gagarin Cosmonaut Training Centre, who have extensive experience in training cosmonauts, including foreign crew members. As flight engineers, Frank and Roberto would be responsible for controlling critical parts of the spacecraft, working very closely with the Soyuz commander during the in-orbit manoeuvres, docking/undocking with the ISS, and the subsequent return to Earth.

Extensive medical examinations are an important part of the mission preparations. These tests took place at regular intervals to check and safeguard the health of the cosmonauts, and hence ultimately also the success of the mission. Equally important and demanding are the sessions for fitting and checking out the Sokol space suits. One such session is a leak test in which the cosmonaut is strapped in his cramped flight position for several hours inside a vacuum chamber. As the Odissea cosmonauts would also be living and working in the US part of the ISS, training sessions at the NASA/Johnson Space Center in Houston were scheduled too.

Although the flight-engineer training involved the greatest preparation time, the scientific objective of the mission was to complete the extensive experimental programme. This meant that as launch approached the crew spent more and more time training to conduct those experiments. This training took place under ESA's control and much of it was done at ESTEC in Noordwijk (NL). The crew worked closely with the scientists responsible for the experiments in familiarising themselves with the equipment and the experimental procedures. Some of this training also took place in Houston, as four of the experiments needed to be performed using the ESA-built Microgravity Science Glovebox for extra safety.

The baseline data collection for the physiological experiments was particularly time-consuming, requiring many samples to be taken from the cosmonauts themselves. These sessions started long before the mission, not only in Russia but also in the Netherlands. The physiological testing intensified close to the launch and was at its peak for a few days after the landing, continuing less frequently for several weeks thereafter.

The Experiments

Belgium's support for the Odissea mission made it possible for a total of 23 experiments to be performed, which would otherwise have had to wait several years for an appropriate flight opportunity. The experiments flown, which were selected by ESA after scientific peer review and an accommodation study, included both Belgian and international experiments and they covered both scientific and educational topics. The OSTC coordinated the Belgian experiments.

Many of the experiments conducted were in the life-sciences domain, ranging from cell research at the DNA level to cardiological and neurological studies on the cosmonauts themselves. In the physics-related field, there were three crystallisation experiments, an experiment to study combustion reactions in a metal mixture, and a fluid-physics experiment to study diffusion in oils. Educational experiments were videotaped for schools, with which there were also amateur-radio sessions during the mission.

Most of the equipment used for the Odissea experiments was developed by the national institutes or by ESA and had been carried to the ISS a few months earlier by an unmanned Progress capsule, while some was already onboard in the NASA laboratory or had been carried up as part of the equipment pool from previous flights.

The three Odissea crew members set out for the launch pad in Baikonur

The Flight

The crew got up very early during the night of 30 October to prepare for the early-morning launch. After the traditional walk from the cosmonauts' hotel in the small town of Baikonur, the three were transported by bus to the launch complex. The Sokol spacesuits were donned four hours before the launch and their air-tightness tested once again. There was then the traditional ceremony in which the crew reported to the State Commission, surrounded by a crowd of invited guests and the media, before being transported to the launch pad. This same pre-launch ritual has been followed since Yuri Gagarin's flight in 1961.

Two and a half hours before lift-off, the three crew members entered the capsule. Thereafter, the radio-links and the air-tightness of the capsule were tested, as well as the air-tightness of the suits one last time. The final flight instructions were loaded according to plan shortly before lift-off and the automated ignition sequence was initiated.

In fact, the launch took place in dense fog, which gave the onlookers the special sensation of only feeling rather than seeing the rocket's ignition and lift-off. The ascent was according to plan and after just 8.5 minutes the Soyuz was in orbit. After all the necessary checks had been conducted, the crew could safely get out of their spacesuits, disconnect their medical monitoring wires and enjoy the relative 'comfort' of the orbital module above the landing capsule.

During the next two days, the crew conducted many tests with the new spacecraft and prepared the capsule for

The Soyuz-TMA spacecraft (right) about to dock with the International Space Station

Frank De Winne at work in the ISS with ESA's Microgravity Science Glovebox

docking with the ISS. During the periods of ground contact, they were able to talk to their families who had gathered in the Soyuz control room in the flight control centre. Despite their limited meals and lack of sleep, they were also able to enjoy their long awaited view from space of planet Earth and to experience life in microgravity.

This maiden flight of the new TMA Soyuz capsule was successfully completed with an automatic docking to the International Space Station on 1 November. After careful checks for any leaks, the hatch was opened and the permanent residents warmly welcomed the visiting trio, for whom floating through the more roomy Space Station modules seemed like luxury after their days in the Soyuz.

After a video conference with officials on the ground, followed by an hour and a half of unpacking, there was plenty of time to chat with family and friends back on Earth before starting eight days of intensive work. The following days were fully occupied in conducting all of the experiments, with the permanent station crew helping out during certain experiments. Equipment had to be started up, experiment cartridges had to be changed, electrodes attached, blood samples taken, ongoing tests filmed, malfunctioning devices repaired, pictures taken of particular locations of interest on Earth – such as the erupting Etna volcano – temperatures checked, videotapes exchanged, questionnaires filled in, etc., etc. Despite this hectic schedule, the experiments worked very successfully, with hardly any delays or problems. 22 experiments were completed, to the great satisfaction of the scientists, the ground teams and the crew.

Several public-relations events were organised during the mission, with the crew communicating sometimes in Dutch and sometimes in French with VIP's, mediators, officials, schoolchildren and students in Belgium and at ESTEC sites, as well as with television crews. In Frank De Winne's hometown, thousands of people gathered in the market square to witness these live broadcasts on giant TV screens.

The Mission Operations

The Odissea mission was controlled from the TsUP flight-control centre in Kaliningrad near Moscow. Through the close cooperation with the Russian flight controllers, the ESA crew-support team was able to be in direct contact with the visiting crew. This ESA support included medical support by a doctor from EAC, who was similarly in close contact with the Russian medical staff. The experiment investigators were gathered at the User Support Operations Centre in Brussels (B), where they could be quickly consulted by the ESA engineers at ESTEC in the event of any problems.

As the ISS crew operates on the basis of Greenwich Mean Time, the people at TsUP work into the night, while their NASA counterparts are active early in the morning. Every day, a so-called Form 24 containing the daily planning was sent to the Station, with other inputs to the crew such as new or updated procedures being conveyed by radiogram or by direct voice communication. The latter rely on a VHF channel when there is coverage by the

Russian ground stations, which occurs only a few times per day. At other times, communication relies on the US ISS segment's S-band link with Houston, including e-mail exchange, and the radio-amateur sessions.

The Return

For the Odissea crew, the 10 days of the mission passed all too quickly. The last two days were mostly spent in packing the Soyuz TM34 return capsule with the experiment results and data carriers, some small items of equipment, and personal belongings. As the allowed volume and mass, as well as the access to the various storage locations, are strictly limited, this is not a trivial task. Most of the experiment equipment is left onboard the ISS for later reuse or is stored in the Progress capsule for subsequent removal and eventual destruction on reentry into the Earth's atmosphere.

Having successfully concluded their hectic programme of experiments onboard the ISS, the visiting crew bade farewell to their colleagues and closed the hatch. Having donned their pressure suits once again and checked carefully that everything was properly sealed, they undocked their Soyuz from the Station and slowly drifted away. The descent operations towards the Earth's atmosphere went according to plan, and the deceleration for reentry was started with a burn of the Soyuz's engines. The living module and the equipment part of the Soyuz were separated from the landing capsule, which entered the dense layers of the Earth's atmosphere soon afterwards. After 10 days of weightlessness, the crew had then to withstand the deceleration forces of re-entry and the subsequent swinging movements that accompany parachute deployment.

The landing was always destined to be an historic one, since it was the first ever Soyuz night landing. For the rescue helicopter crews, the intense glow of the returning capsule provided an impressive and quite unique sight. The landing itself was a hard one due to the frozen ground and the repeated tumbling of the capsule before it finally came to rest on its side.

The Soyuz capsule on the frozen steppes of Kazakhstan, after its historic first nighttime landing

The jubilant Odissea crew safely back on terra firma: from left to right, ESA astronaut Frank De Winne, and Russian cosmonauts Sergei Zaletin and Yuri Lonchakov

Although in a rather uncomfortable position, the crew were in good health and good spirits when the support team reached them. The ESA support personnel retrieved the time-critical scientific samples and other important items from the capsule and the three crew members were taken to a tented facility for a medical check-up. There they were also able to share their experiences with colleagues, friends and officials, including the Belgian Crown Prince.

Reflecting on all that had happened during his hectic first voyage into space, Frank described his experience as 'the most intense, challenging and unbelievably fulfilling 10 days of my professional life'.

This, however, was not the end of the mission for the Odissea crew, who still had to submit to the many post-flight medical tests in the days to come, in order to assess their re-adaptation to normal gravity conditions. The scientific researchers, of course, also have lots of work ahead of them on all of the data brought back from the ISS and will only be able to draw definitive conclusions from their experiments several months from now.

Conclusion

The Odissea mission was extremely successful, with all of the main goals – the testing of the new Soyuz vehicle in flight, the exchange of the Soyuz vehicles as rescue craft for the ISS, and the scientific/educational programme – being achieved exactly as planned.

The cooperation on the ground between all of the international partners at the different sites worked well, with the few difficult issues that did arise being resolved in a very professional way. The Odissea mission therefore stands out as a good example of how such nationally funded missions can serve the national, European and international scientific community and can help to stimulate the youth of today to choose technical and scientific careers. The experience gained during this 'extra' mission will also be very useful for the preparation of the next Soyuz flights, carrying ESA astronauts from Spain and The Netherlands.