“Moon Landing” performed by Test Pilot Roberto Vittori
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How will astronauts land safely on the Moon in the future? A seamless interaction between pilot and spacecraft is crucial to ensuring a successful Moon landing. Together with partners from industry and research, the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt, DLR) has conducted a special experiment. European Space Agency (ESA) astronaut and test pilot Roberto Vittori has tested various lunar landing maneuvers for the first time during a fully mobile simulation in the flight deck of the 'DLR Robotic Motion Simulator'.

ESA astronaut Roberto Vittori tests maneuvers
The motion simulator was developed at the DLR Institute of System Dynamics and Control and allows for extreme tilt angles and maneuvers. As a test pilot in the simulator in Oberpfaffenhofen, the ESA astronaut was able to experience how a spacecraft behaves during critical flight phases and intervene to control it. This experiment is part of the ESA project 'Human-in-the-Loop Flight Vehicle Engineering for Exploration Missions'. Within this project, technology studies are being carried out for crewed landings at the Moon's South Pole.
In one test scenario, the auto pilot was set to land in a landing zone with boulders. Vittori was able to intervene within a given time window and select an alternative landing site free of boulders via touch screens. In another scenario, the autopilot experienced a technical fault. Here, the Italian astronaut was able to switch to fully manual control and successfully pilot the module manually as it descended onto the lunar surface.

Human-machine cooperation
A primary goal of the ESA project is to evaluate human-machine interfaces and assistance functions for spacecraft. For this purpose, the project participants developed a human-in-the-loop simulation that enables an astronaut to interact with the control system of the simulated lander. To simulate the final phase of a lunar landing, the DLR researchers converted the motion simulator into a lunar module. The DLR Robotic Motion Simulator is based on an industrial robot arm with a flight deck capsule attached to the end. The system is highly customizable and has a particularly large available workspace. In contrast to classic mobile flight simulators, the DLR Robotic Motion Simulator makes it possible to achieve extreme tilt angles and maneuvers.
"It was a beautiful run," said ESA astronaut Roberto Vittorio, stressing the intuitive feeling for motion the simulation system gave him. "The simulator is an incredible machine, probably one of the best I have experienced. This experiment is for me showing that Europe can play a key role in the future of exploration."

Successful ‘Moon landing’ using the DLR robotic motion simulator (right)
European Space Agency (ESA) astronaut Roberto Vittori has tested various lunar landing maneuvers for the first time in the flight deck of the ‘DLR Robotic Motion Simulator’. The motion simulator was developed at the DLR Institute of System Dynamics and Control and allows for extreme tilt angles and other extreme constraints and conditions. Credit: © DLR. All rights reserved

For this experiment, the DLR team equipped the capsule with touch screens, new input devices for the astronaut and a virtual flight deck window. The researchers also developed a high-resolution lunar visualization that allowed the maneuvers of the lunar module to be observed on a large screen outside the simulator.

Vittori inside the simulator capsule (nose cone open), on the right the closed nose cone and the panoramic view of the landing site as presented to "mission control" during Vittori's touch down of his simulated lunar landing vehicle.

Intuitive, realistic control

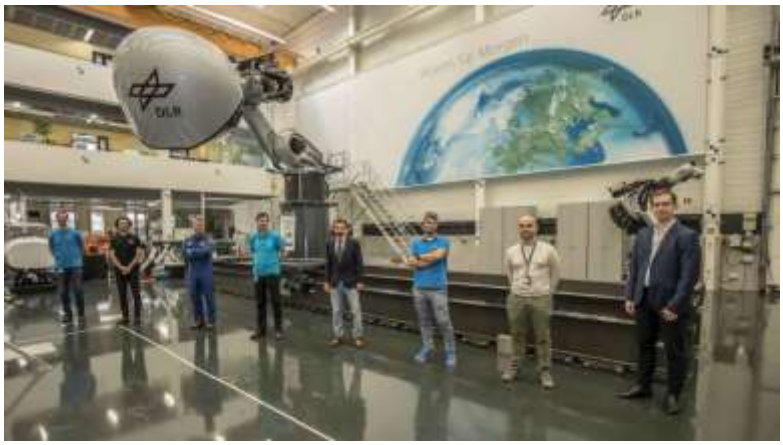
Another goal of the ESA project is to investigate in greater detail how well an astronaut can control and navigate the lunar module while under the influence of motion. The resulting findings will be used to define the technical requirements for future lunar landing missions. As part of the project, DLR researchers are also studying how the conditions and effects of motion that occur in lower gravity can best be simulated on Earth.

After the series of experiments was completed, the Italian ESA astronaut Vittori was extremely impressed by the facility in Oberpfaffenhofen and emphasized that the motion simulation gave him an intuitive feeling for the lander, which allowed him to control the lunar module in a realistic way. ESA project manager Luca Ferracina commented: "The experiment has clearly shown that the DLR Robotic Motion Simulator is very suitable for conducting this type of tests."

About the project

The Technical Directorate of the European Space Agency (ESA) has initiated the project 'Human-In-the-Loop Flight Vehicle Engineering for Exploration Missions' as part of preparations for the planned Lunar Orbital Platform-Gateway (LOP-G) space station. Among other things, the gateway is to serve as an intermediate station for crewed missions to the Moon.

The project is funded by ESA and is a collaboration between research and industry. Project partner Thales Alenia Space from Italy provided the user interfaces for maneuver control, in particular the software for the touch screens. The navigation and flight control of the simulated lunar module was developed by the Spanish company Grupo Tecnológico e Industrial GMV S.A. and adapted for the DLR simulator. The Robotic Motion Simulator was developed at the DLR Institute of System Dynamics and Control.



Mission Control during the simulation test (left) and a very proud DLR simulation team with Astronaut Vittori after the successful testing of the innovative DLR robotic motion simulator.

Reference:

https://www.dlr.de/content/en/articles/news/2022/02/20220407_moon-landing-performed-with-dlr-robotic-motion-simulator.html

All images: Curtesy of DLR

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