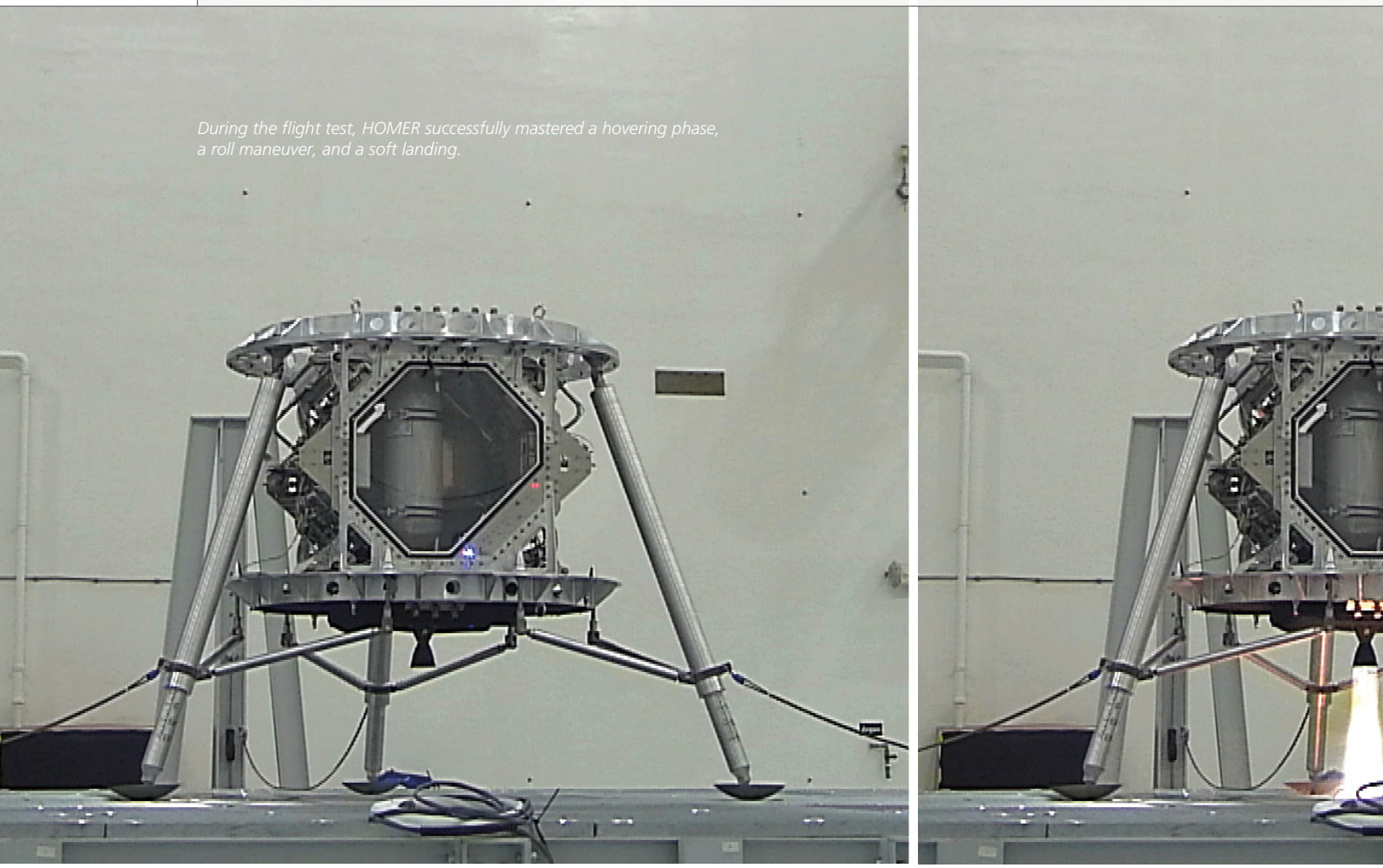
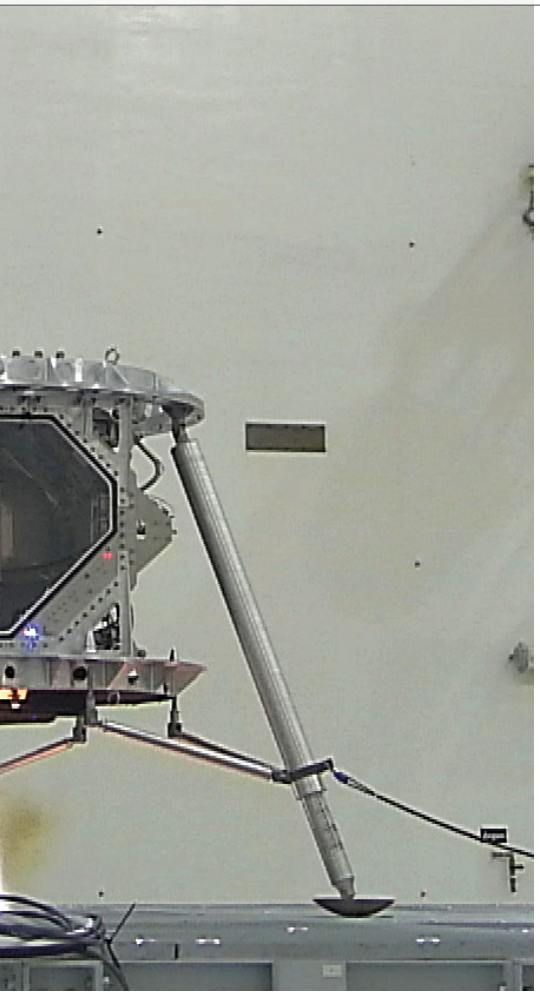


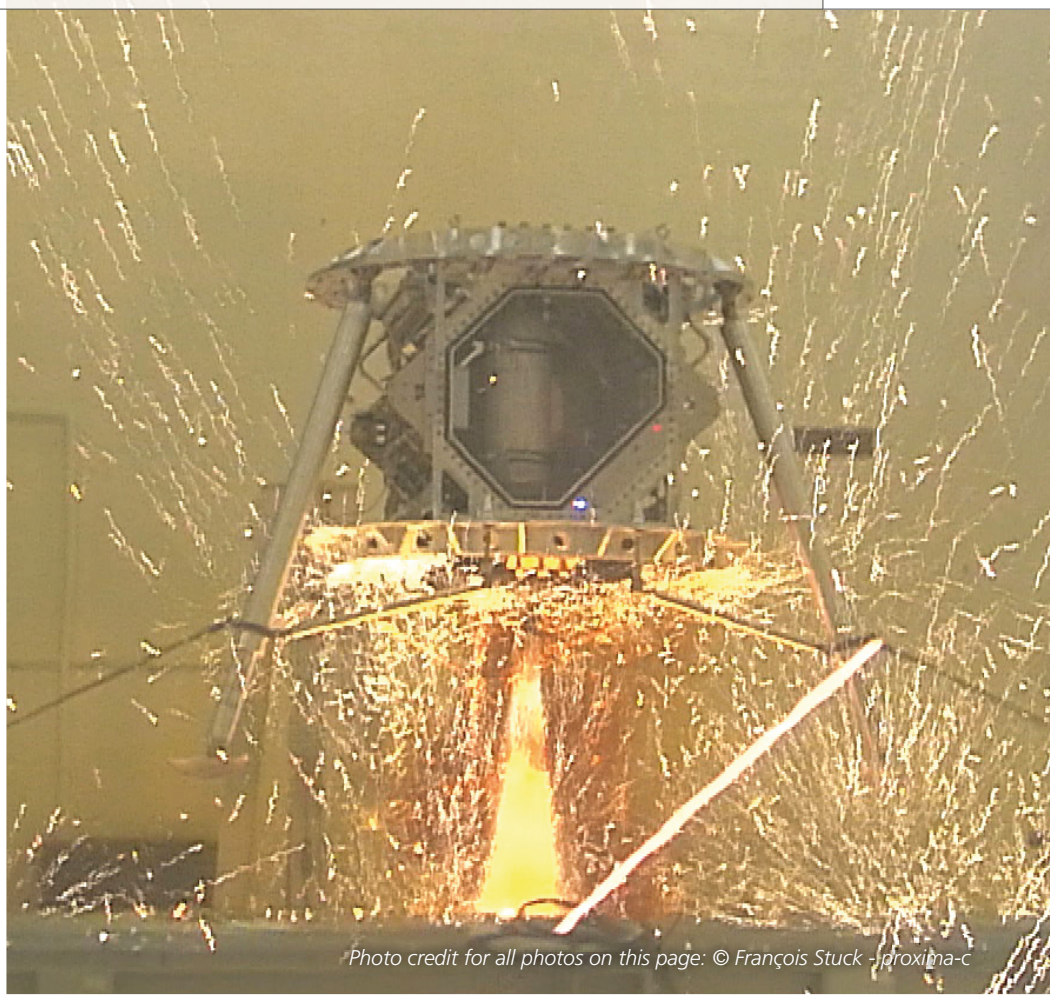
During the flight test, HOMER successfully mastered a hovering phase, a roll maneuver, and a soft landing.

HOMER Take-off: A Review

With HOMER (HOver ManoEuvRe), Airbus Defence and Space had developed an innovative two-in-one prototype for future space vehicles that masters both landing and hovering maneuvers. Two dSPACE MicroAutoBoxes were on board to control the test flights.

At Airbus Defence and Space, the HOMER project was a novelty when it comes to the products it used. For the very first time, commercial off-the-shelf (COTS) products were used for such a complex development task. HOMER was one of Airbus Defence and Space's five most distinguished projects. Its goal was to assess the maturity of new technologies and the associated know-how, and to develop new key competencies. HOMER can be thought of as a kind of incubator for new technologies. One of the main challenges of its development was the limit on weight and volume (max. 300 kg for a volume of 1 m^3). The requirements for other projects at Airbus Defence and Space are less strict because they develop far





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"Our successful utilization of dSPACE products for the HOMER project allows us to strongly and confidently consider dSPACE solutions for further R&T projects."

Stéphane Heynen, responsible for Ground Control Systems, Airbus Defence and Space

larger space vehicles of twenty tons or more.

Space Vehicle in Two Variants

HOMER can be configured for two use cases. One version was optimized for landing maneuvers, the other for hovering maneuvers (figure 2). The landing version of HOMER (Lander, for the ODYSSEY mission) has shock-absorbent landing legs and an engine for vertical movement. The hovering version (Impactor, for the ILIAD mission) does not have a landing system but rather two additional engines for lateral movement. The first tests focused on the Lander version.

Interdisciplinary Development Across Countries

Six Airbus Defence and Space offices were involved in the HOMER project: two from France, four from Germany. A new organizational structure had to be created from scratch to guarantee seamless cooperation. A typical example for this is the collaboration of teams from simulation and flight control, who were merged at Airbus Defence and Space. This project team counted approx. 25 employees who were divided into several groups of both French and German engineers. Each group focused on one subtask, such as the attitude control system or the main propulsion system.

Rapid Control Prototyping with dSPACE Tools

The COTS system for developing HOMER's hardware and software had to meet strict requirements for I/O capability, weight, and configurability, because a lean and cost- >>

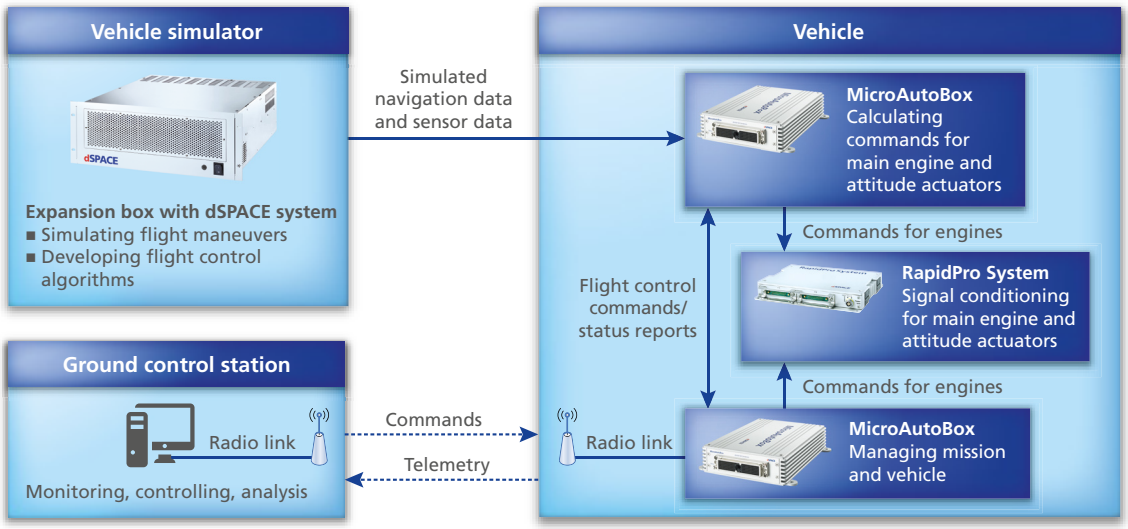

Figure 1: To develop the flight control algorithms, HOMER was connected to a modular dSPACE system in a dSPACE Expansion Box. This made it possible to simulate the flight maneuvers and associated sensor data before the actual test flight.

effective development system must not compromise safety. The choice eventually landed on dSPACE tools because they had been tried and tested in previous projects at Airbus Defence and Space. The flexible I/O of dSPACE MicroAutoBox made it easy to connect existing hardware. This hardware included an inertial navigation system, a camera, a radar altimeter, as well as different sensors and actuators. Function design was made easy by the model-based approach, i.e., model design in MATLAB®/Simulink® and automatic code implementation on the dSPACE hardware (figure 1) via Real-Time Interface (RTI). "The most striking advantages of the dSPACE tools are their easy configuration directly from the block diagram, the many possibilities for instrumentalization in the experiment software ControlDesk, and their real-time capability," says Thierry Poirrier, who was in charge of developing HOMER's electrical subsystems. During the development process, a total of five MicroAutoBox configurations and RapidPro power stage configurations, including the associated implementation and experiment software, were used.

Test Flight with Two MicroAutoBoxes

HOMER was assembled at the Airbus Defence and Space facilities in Bremen and then shipped to the test center in Aquitaine, France. On October 23, 2012, HOMER passed the validation test, which consisted of a hovering phase, a roll maneuver, and a soft landing from 1 m above ground (see video). "HOMER has been approved at system level," reports Stéphane Heynen, who is responsible for ground control systems. Two dSPACE MicroAutoBoxes were installed in HOMER: one dedicated to the mission and onboard system management, the other to concrete flight control. Because of the extreme vibrations that HOMER is subjected to, especially during takeoff and landing, an environment expert recommended putting additional absorbent foam inside the MicroAutoBoxes to ensure that they work properly during the test flight.

Accelerating Development by 9 Years

"For this prototype, it took us only 4 years to get from our first work

"We used dSPACE products all along the development and validation process. The cost-effective dSPACE tools were used on all tests systems and ensured the representativeness of the test results."

Thierry Poirrier, responsible for Electrical Subsystems, Airbus Defence and Space

"The dSPACE products provide fast, reliable, and robust real-time prototyping tools, letting us focus on our core activities."

Clément Gu, responsible for Simulation and Flight Control Software, Airbus Defence and Space

steps to finishing the Lander version. For an operational vehicle, this process usually takes around 15 years in space flight projects," states Clément Gu, who developed the simulation and flight control software. Airbus Defence and Space is the first space flight company in Europe with such test flight competence. Because the new technologies and work methods proved successful, Airbus Defence and Space will continue to use them in future space projects. One such project could be a space vehicle for removing space debris, which requires high-precision propulsion, control, and docking abilities. ■

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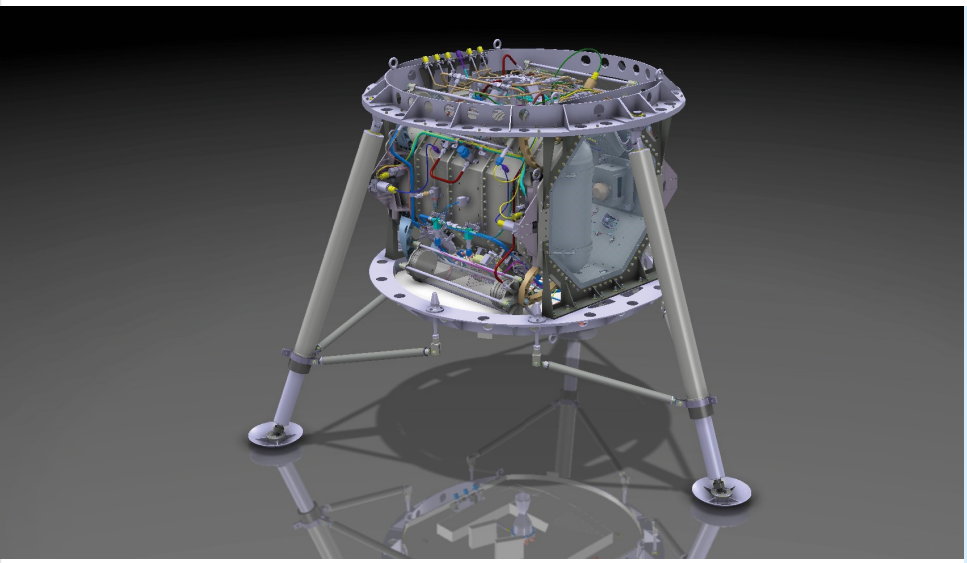
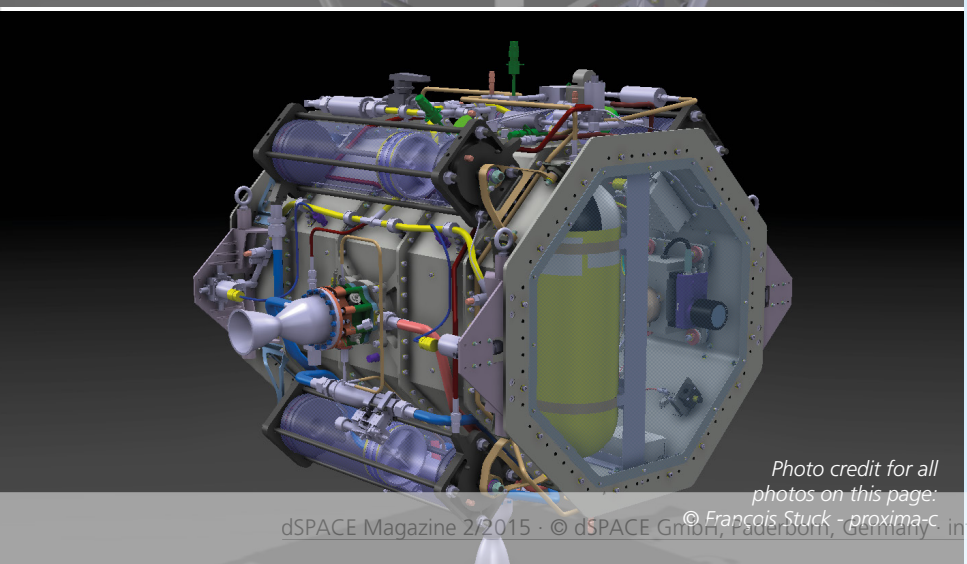
Figure 2: Top: the Lander version (one vertical engine, three landing legs). Bottom: the impactor version (one vertical engine, two horizontal engines instead of landing legs).





Conclusion

With HOMER (HOver ManoEuvRe), Airbus Defence and Space had developed an innovative multifunctional prototype for future space vehicles that mastered both landing and hovering maneuvers. Various dSPACE products were involved in HOMER's development test flights: e.g., two MicroAutoBoxes for onboard flight control. HOMER took only 4 years to develop instead of the usual 15 years for such a space flight project. The HOMER project has now been successfully completed.

This video shows HOMER's first test flight: www.dspace.com/go/dMag_20152_HOMER

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