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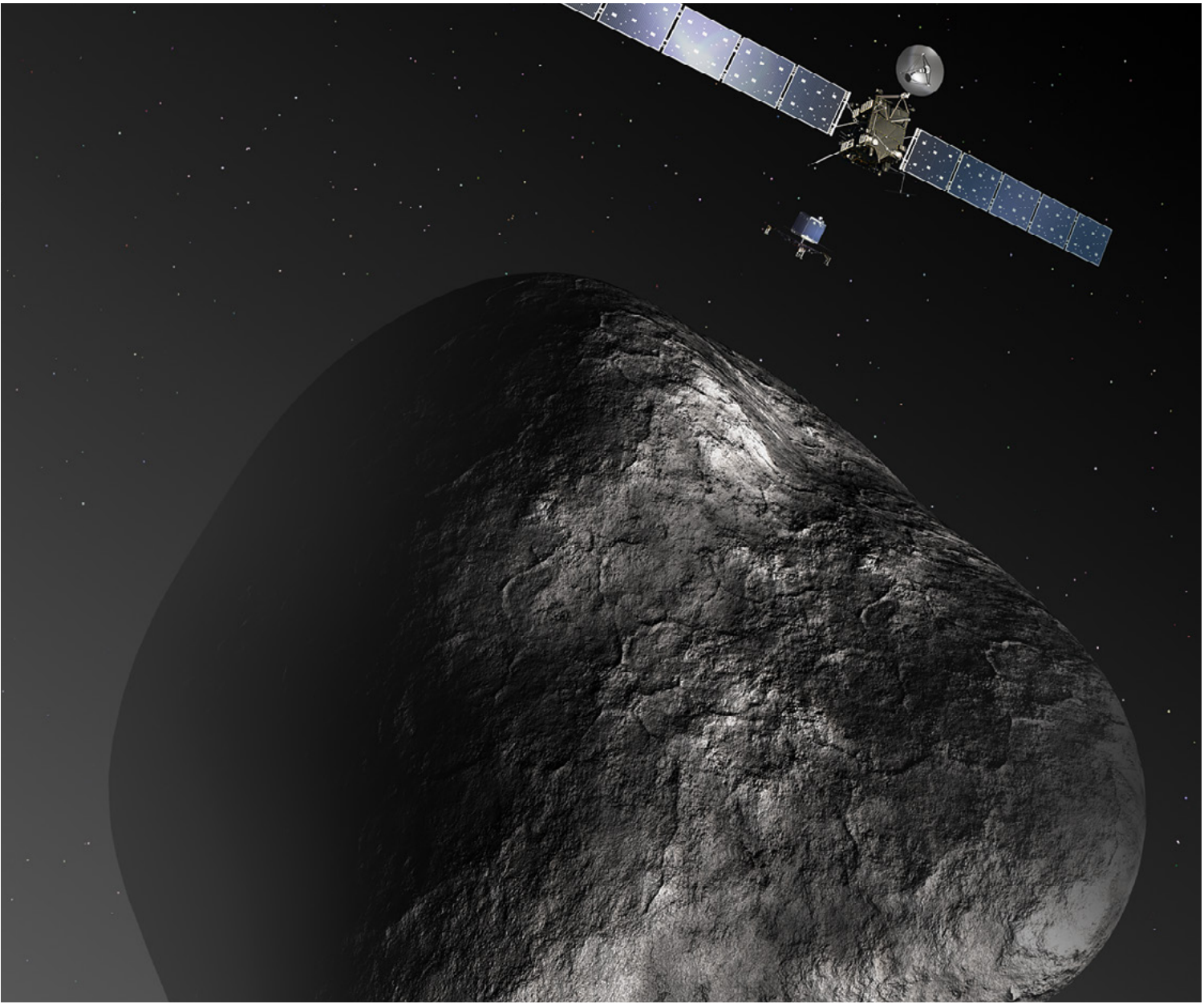
LANDING ON A COMET

AEROSPACE & DEFENSE



Scientists watched with bated breath as the Philae lander left the European Space Agency's Rosetta spacecraft and touched down on the surface of a comet last November after a 10-year, 4-billion-mile journey. Among those glued to their screens was Dr. Martin Hilchenbach, one of the original designers of the lander. He and his team used SIMPACK simulation software (now part of the Dassault Systèmes SIMULIA portfolio), between 1996 and the 2004 takeoff of Rosetta from Earth, to model scenarios for the Philae's landing and guide design changes that helped ensure its survival. A presenter at the 2015 SCC in Berlin, Dr. Hilchenbach answered some questions for SCN earlier this spring:

How did you end up on the Rosetta team, designing a vehicle to land on a comet?

Hilchenbach: Raised in the industrial part of Germany during the Apollo lunar landings, I studied physics, atomic physics, immunology, laser physics, and photochemistry in Austria and the U.K. I finally achieved a "dream job," in plasma research based on satellite data and instrument hardware development, at the Max-Planck-Institute for Extraterrestrial Physics. Moving to what is now the Max Planck Institute for Solar System Research, I became involved with subsystem development as research scientist for the Rosetta lander, Philae. My first thought when learning of the project was "Great, this has never been done before, it's a new field to explore and, best of all, unlike modeling and data analysis alone, at some point we will know if we got it right!"

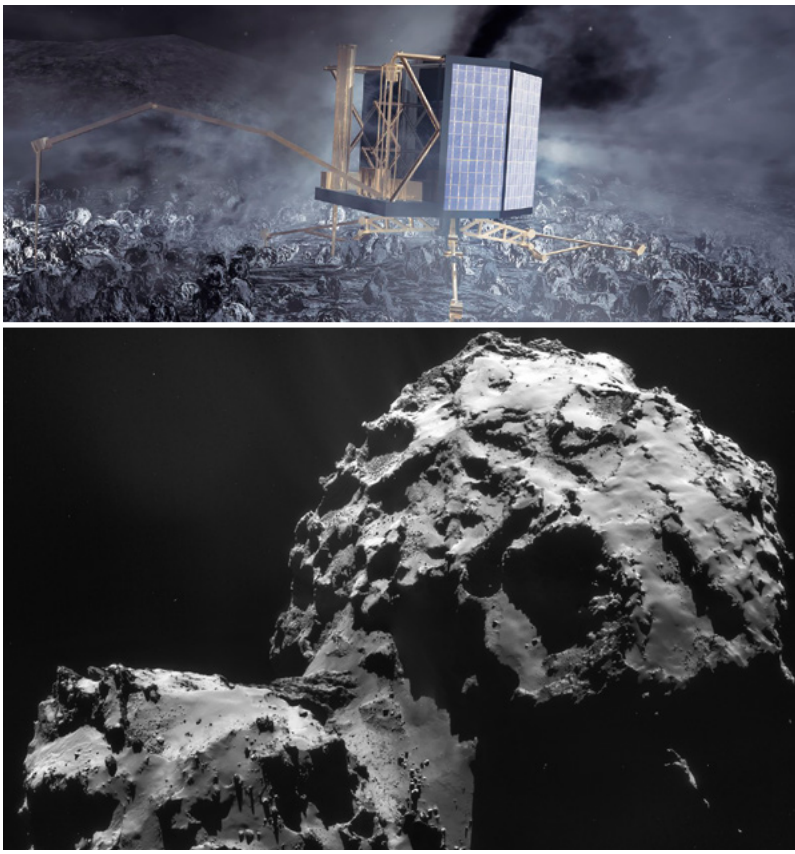
In what ways was your work supported by the use of SIMPACK software?

Hilchenbach: The multibody simulation program package SIMPACK was extremely useful, with a robust solver and solid concept, but even more for the capability to easily transfer CAD data and then present the various SIMPACK simulations as 3D "videos" and visualize the advantages and disadvantages of the proposed technical approaches. During the Rosetta development project the software evolved nicely and the interfaces (as well as computer hardware and processing speeds) improved very much. From what I have seen from my colleagues still applying SIMPACK, the overall design has further improved and the interfaces look even better.

The principle that simulation needs to be carried out in close proximity to real hardware and engineering design envelopes is still valid. We tested in an Earth gravity environment to obtain force, joint and other specifications for our models, then just switched the gravity environment from terrestrial to cometary to get a nice, hopefully real, impression of how the actual lander would behave in an environment one cannot really test on Earth.

Describe your feelings during the actual landing of Philae. How did it compare to your simulations?

Hilchenbach: It was very exciting! We were finally seeing the real thing (with a half-hour time delay) after years of simulations. Thanks to the Rosetta orbiter's cameras, we were able to image Philae's free fall—it was like sitting right next to the comet and watching reality unfold. From our simulations I assumed, quite



(Top) The Philae lander at work on Comet 67P/Churyumov-Gerasimenko.
(Bottom) Comet on 10 January 2015 – NavCam.
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rightly, that Philae would need all three subsystems to work perfectly: the damping mechanism, the hold-down thruster and, most important, the anchoring with the harpoons. After about 20 minutes it became clear that Philae endured the landing in good shape but the harpoon/anchor system did not work and it was hopping across the comet nucleus. The fourth impact, where the lander became wedged in a final resting place, demonstrated that you can secure a lander on a comet without the action of a harpoon/anchor! But the fact that Philae stayed intact, and its pre-programmed activities continued, is testimony to the robustness of the software that we used to finalize its design.

What are you working on now?

Hilchenbach: I am still a staff scientist at Max-Planck and, over the past decade, my focus has been on in-situ analysis of cometary dust as Principal investigator for the COSIMA instrument team of the Rosetta orbiter. But I am keeping an eye on Philae as the comet comes closer to the Sun in May. Over the past few months it's been in a colder environment than it was intended to withstand, but there is a slight chance it will "wake up" and transmit additional data.

For More Information

www.mpg.de/8323582/wakeup-Rosetta

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