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Independent research in weightlessness - interview with Dr Peter Preu on DLR's parabolic flights

22 May 2006

Dr Peter Preu

For the past six years, the German Aerospace Center (DLR) has conducted a highly successful parabolic flight campaign using an Airbus A300 aircraft, dubbed 'Zero-G'. The flights enable scientists working in the fields of human physiology, biology, physics and materials science to conduct research while weightless as well as under increased gravity, up to 2g. During the 2004 campaign, a total of 124 parabolas with 24 experiments were flown, generating 46 minutes of weightlessness and 92 minutes of approximately twice normal gravity (1.8 g).

The flight days follow a fixed operational sequence. Researchers start early in the morning with final preparations for their test subjects and samples. Then, it's time for medications: Since humans on Earth normally only experience weightlessness for brief moments if at all, a parabolic flight can feel similar to a turbulent sea voyage and upset one's sense of balance. This can lead in some cases to nausea, and thus anti-nausea medicine can help considerably. All passengers then don blue flight suits and board the A300 Zero-G aircraft. For some 30 minutes, all systems on the Airbus are tested and checked and then the aircraft finally takes off. Once at cruising altitude and with the 'fasten seat belts' sign off, scientists start their experiments and research results begin to flow, even before the first parabola.

After some 30 minutes, the aircraft reaches the campaign flight area, in which normally 31 parabolas are flown. The initial 'zero-th' parabola is an exacting exercise for the crew, followed by Parabolas 1-30 for the researchers. These are divided into six series of five parabolas each. During short level flight

breaks between each series, researchers can adjust parameters and settings on their experimental apparatus as necessary as well as swap medical test subjects. After landing, all scientists and the flight crew meet for a debrief in which the aircraft captain reports on the flight and on any problems or issues that might affect interpretation of experimental results. From such debriefings, any necessary changes to the flight profile or procedures can be implemented for future flights, helping to continually optimise research effectiveness.

Video: DLR Parabolic Flight Campaings (german) - View

Question: Dr Preu, simply drawing a parabola on paper for some is quite difficult. Flying a parabola must be even more so. How does it work?

Dr Peter Preu: The Airbus A300 Zero-G is the world's largest flying laboratory for research under conditions of weightlessness. Humans can work onboard while weightless for short times, without actually flying into space. Since 1999, DLR has conducted an annual parabolic flight campaign and makes this unique flight opportunity available to scientists from universities and other institutes for experiments under zero gravity. Researchers address a broad spectrum of scientific questions from medicine, biology and physics as well as materials science. The Airbus offers a fantastic environment for such research. Onboard, 40 scientists can work, operating up to 15 experimental apparatuses per flight day. In Germany, we conduct the flights from Cologne-Bonn airport, from where we started flying in 2004.

Question: The parabolic flights must be, as the name implies, a fantastic experience of curving up, then down. Do passengers ever fear this experience?

Dr Preu: Yes, like a gigantic heavenly roller coaster, the plane arcs up and then down. The plane's trajectory is, however, always straight ahead and it flies without banking to either side. With a speed upwards of 830 km per hour, passengers experience periods of weightlessness during the dives interspersed with a pull of almost twice the normal force of gravity during climbs. On flight days, 31 parabolas are flown; 31 times the plane arcs up and then down, each one lasting about a minute. These provide 31 opportunities for generating successful experimental results and a really great feeling of accomplishment for participants. There's no need for fear, thanks to the the calm professionalism and experience of our aircraft commander, Captain Gilles Le Barzic, from France, and his team. Over 6000 parabolic flights have been successfully completed by their company, French flight operator Novespace, in the past few years, all completely problem-free.

Question: How can researchers continue to work despite this continuous up-and-down motion?

Airbus A300 Zero-G

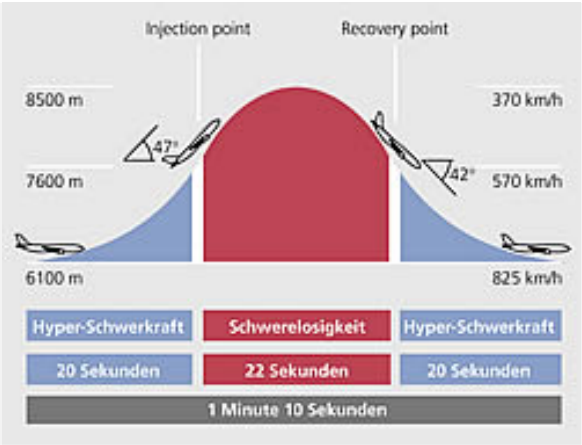
Dr Preu: One can work inside the aircraft very well. Every measure is taken by our French partners and DLR project management to ensure that the scientists obtain optimal conditions. But there remains some portion of success that depends on the scientists themselves, their preparations for the flight and,

naturally, their level of physical fitness. It is fascinating to see scientists from the most diverse fields of research working together in such a unique laboratory, as well as students. The students in particular gain a very positive impression of the excitement of real research, which they carry forward in their later careers as engineers or scientists. The TEMPUS experiment vessel is one classic example of the efficiency of research work done on parabolic flights. Within 22 seconds of achieving weightlessness, a complete test process will be conducted; this includes first melting a metallic sample, then conducting precision measurements on the freely floating liquid metal, and finally cooling the sample back into the solid state.

Question: Is there any other possibility to create weightlessness on Earth?

Dr Preu: First, I would like to say that "weightlessness" is, physically, no different from what you experience in free fall. If you simply drop something or if you throw an object away, it will -- until the point of impact on the surface -- experience the condition of weightlessness. Thus, weightlessness is itself actually nothing very exotic. However, this condition is normally attainable on Earth's surface only for very short times.

For example: consider children playing on a trampoline; they feel weightlessness, but only for a fraction of a second. But the principle from such play is the same as with the parabolic flights. The child jumps up, and feels weightless, then lands and feels gravity, just as the researchers onboard the aircraft do, but now for a period significantly longer. Weightlessness over a longer time span -- hours or days -- can be reached only on a spacecraft such as the International Space Station or on a satellite in orbit; such spacecraft are also in free fall around the Earth. For short-time experiments on Earth, we use also use the Drop Tower in Bremen, a tall tower that offers up to five seconds' weightlessness enabling top-quality research possibilities in biology, physics, flammability and material sciences. In earlier centuries, for example, weightlessness was used for the production of cannon shot pellets because, while weightless, liquid metal solidifies into a useful spherical shape.



Parabolic flight manoeuvres

Question: But why not actually conduct these experiments in space? Why use parabolic flights?

Dr Preu: We must use different tools to solve different problems. Parabolic flights have two functions: First, the scientific and technical preparation of long-term experiments for implementation onboard the space station. Parabolic flights serve, therefore, as a stepping stone. Second, the flights make possible independent research in those specific areas for which 22 seconds of weightlessness are sufficient, and there are many. Additionally, parabolic flights offer more advantages. They are regularly available, economic and provide fast results. Also, the scientists can accompany their experiments and even perform mid-flight adjustments; this is more difficult or impossible with experiments sent into orbit on the space station. Moreover, we can promote science among a new generation with these flights. The research teams include many young researchers as well as students and they gain a strong sense of identity with "their" projects and their successes. And the high point of each campaign in the Airbus is, of course, the fascination of personally experiencing weightlessness. All this contributes to innovation in Germany, the gathering of excellent scientific results and motivates and promotes science among researchers of the future.

Question: How do you select the experiments? How can scientists participate in a parabolic flight?

Dr Preu: Very simply, by submitting a good experimental suggestion to DLR's Space Agency. Anyone can do this anytime. All suggestions are then scientifically assessed. With a solid idea and a little luck, you have a good chance of flying with the next campaign. DLR can also provide organisational and, if necessary, financial assistance. But I must say, demand in terms of the number of experimental ideas submitted for each campaign exceeds the capacity, so it's important to have a very good idea.

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