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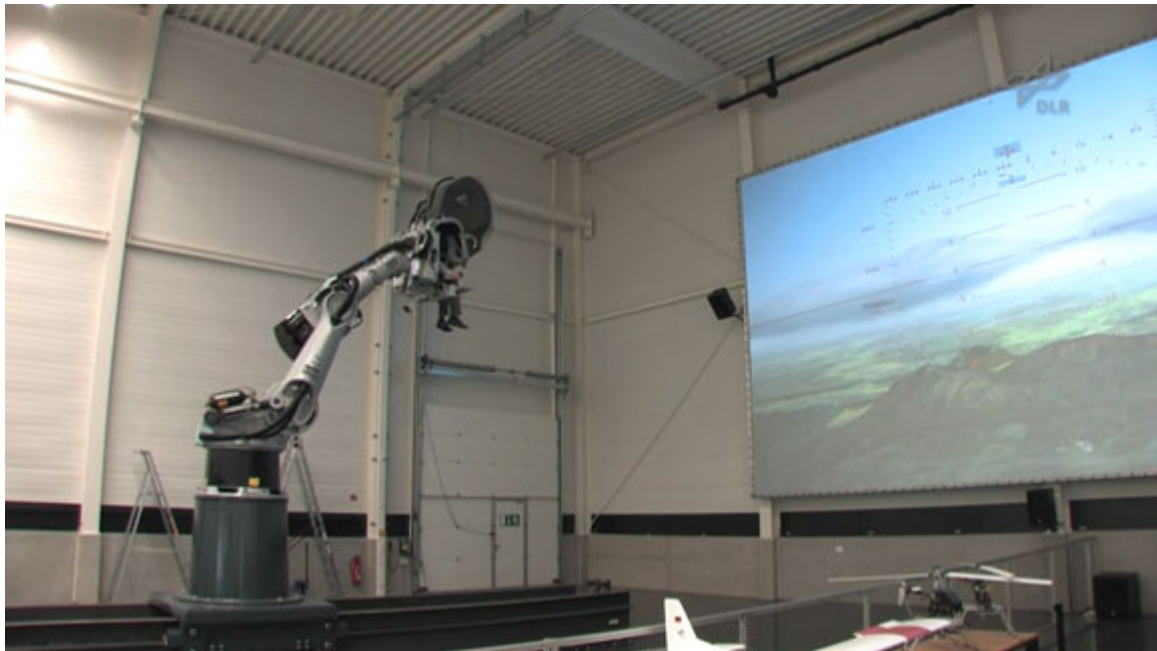
## News-Archiv Transport 2010

### Virtual flight on a robotic arm

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By Manuela Braun

Only Andreas Knoblach's legs hang out from under the cover of the 'cockpit'. They are dangling in five metres above the ground while the enormous robotic arm slowly swivels the virtual-reality 'capsule' and its occupant and moves along a track in front of a large screen. Mountains, valleys and meadows are visible. Knoblach can see the same scene on a screen in front of him. He is about to begin a flight that simulates everything. It lasts only a few minutes and he has already turned upside down and back again. The robotic arm moves forwards and backwards, swivelling the man at the joystick up and back down again. Finally the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) scientist ends up sitting upside down in the capsule while he flies virtually through the air in a twin-engine light aircraft, working his way through spectacular aerobatic manoeuvres.



The forces affecting him as he does so allow him to experience one thing in particular: how it feels when the acceleration pushes a pilot into his seat. The same applies to the simulation of a light aircraft, a trip in a virtual car or a helicopter flight.



Andreas Knoblach in the Robot Motion Simulator

### **A whole body experience**

Researchers at the DLR Institute of Robotics and Mechatronics have achieved this by significantly extending the freedom of movement of a conventional Robocoaster, as they are known in amusement parks. The robotic arm is not attached to a fixed point but travels forwards and backwards on a 10-metre-long track, along with the capsule and its occupant. "This enables us to carry out even larger manoeuvres such as evasive tactics with almost complete accuracy," says DLR researcher Tobias Bellmann. Among other things, he is responsible for the path planning, which sets out the sequence of movements for the robotic arm. "Translating acceleration in the real world to the simulated world is a complex task." The simulator's movements further enhance perception with the eyes and ears, through the whole body's perception – acceleration, rolling turns or braking manoeuvres travel through the legs, eyes and balance system and ultimately give the impression that you are actually sitting in an aircraft.

### **Simulator carries out control movements**

Up in the air, Andreas Knoblach can feel with his own body how well his colleagues have implemented the path planning algorithms. With his right hand on the joystick, he controls his 'plane' independently above the Alps, flies upwards close to a mountainside and dives back into the valley beyond the ridge. Robocoasters have already been used in amusement parks for some time – although in those cases the robotic arm executes a preset program that the passengers cannot alter during the ride. But it is quite different in the hall at the DLR site in Oberpfaffenhofen – every control movement made by the pilot is implemented directly by the DLR Robot Motion Simulator.

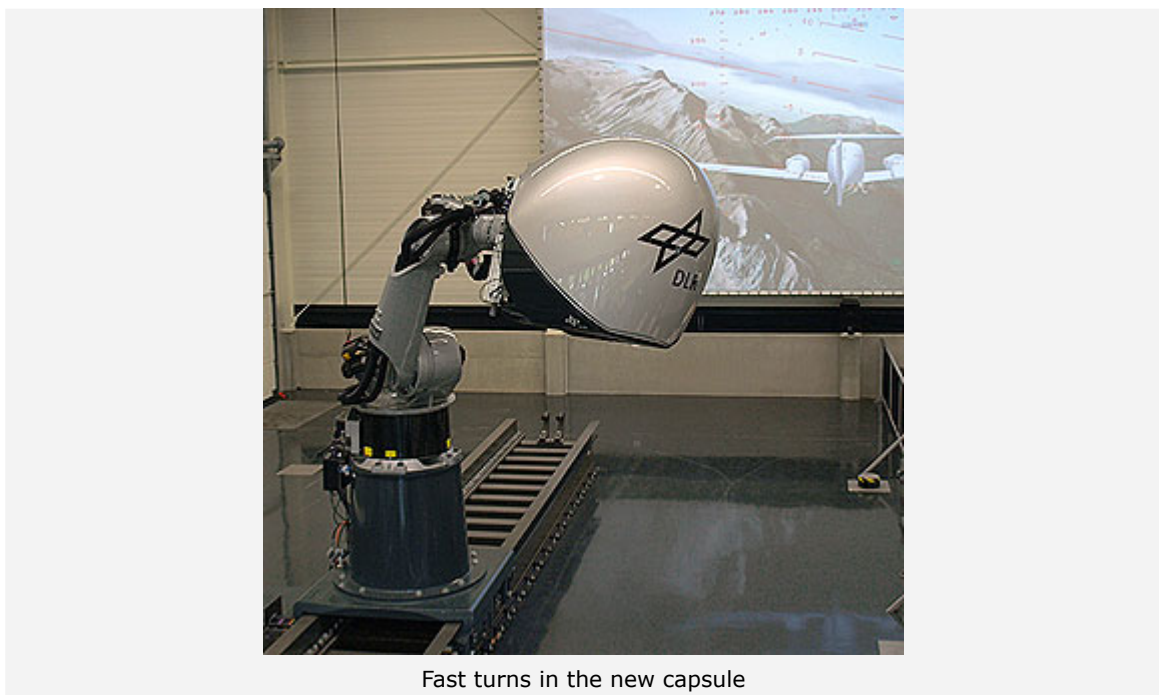


Andres Knoblach's face is visible on a monitor in the control room. A small camera is transmitting the image from the capsule. Project leader Johann Heindl sits and watches the computer screens and displays. "Everything OK?" he asks; the pilot and ground team communicate with one another via radio. A panic button in the capsule ensures that the robotic arm can return to its starting position quickly and gently in the event of an emergency. This is not the first time Knoblach has flown and he knows how far he can trust himself and the DLR Robot Motion Simulator.

#### **Modular system for new scenarios**

Enabling the DLR Robot Motion Simulator to respond so flexibly to all its pilot's input requires a great deal of work in advance. The vehicle or plane's acceleration is calculated using a set of algorithms to move the robotic arm. Driving and flight dynamics libraries that the institute has developed form the basis for the simulations. For example, various aircraft masses, engine powers, wind strengths and air currents have been stored for flight simulations. This means that new scenarios can be created from these various elements via a modular system and precise path planning can be carried out.

#### **Progress using a newly-developed simulator capsule**



Using a newly-developed simulator capsule that is currently being tested, researchers at the DLR Institute of Robotics and Mechatronics are taking another step towards the most realistic simulations possible. Different mounting points enable the new capsule on the robotic arm to simulate additional scenarios. Fast turning manoeuvres such as spinning in a car or helicopter are just as possible as a horizontal roll in an aircraft. During the simulation, the passenger is almost completely enclosed and sees the virtual landscape or road not on a small screen, but as a stereo projection on the entire inner

surface of the capsule. In addition to this 3D view, authentic background noise is supplied via loudspeakers. The interior of the capsule can be modified depending on the simulation – if the passenger is meant to have the illusion of driving on a racing circuit in a car, a steering wheel and pedals are installed; if he is a pilot flying through the air, the capsule is fitted with a side stick, rudder pedals and a throttle lever. "Thus, the simulator can be set up in different ways," says Bellmann. The individual instrument packages are complete units with control instruments, seat and loud speakers and can also be used separately as a static simulator. "We want to develop a new type of simulator that is not only cheaper than comparable simulators by a factor of 10 or even 20 because of its mass-produced robotic mechanics, but also has a much larger working area for the same installation space."

In the Robot Motion Simulator, Andreas Knoblach has already experienced that – luckily – virtual reality also has its limits. After several climbs and dives, curves and loops, he flies straight into a mountain; but the crash has no consequences. "We haven't enabled any collisions," says Bellmann on the ground. "Purely for safety reasons."

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