Airmotion_ride

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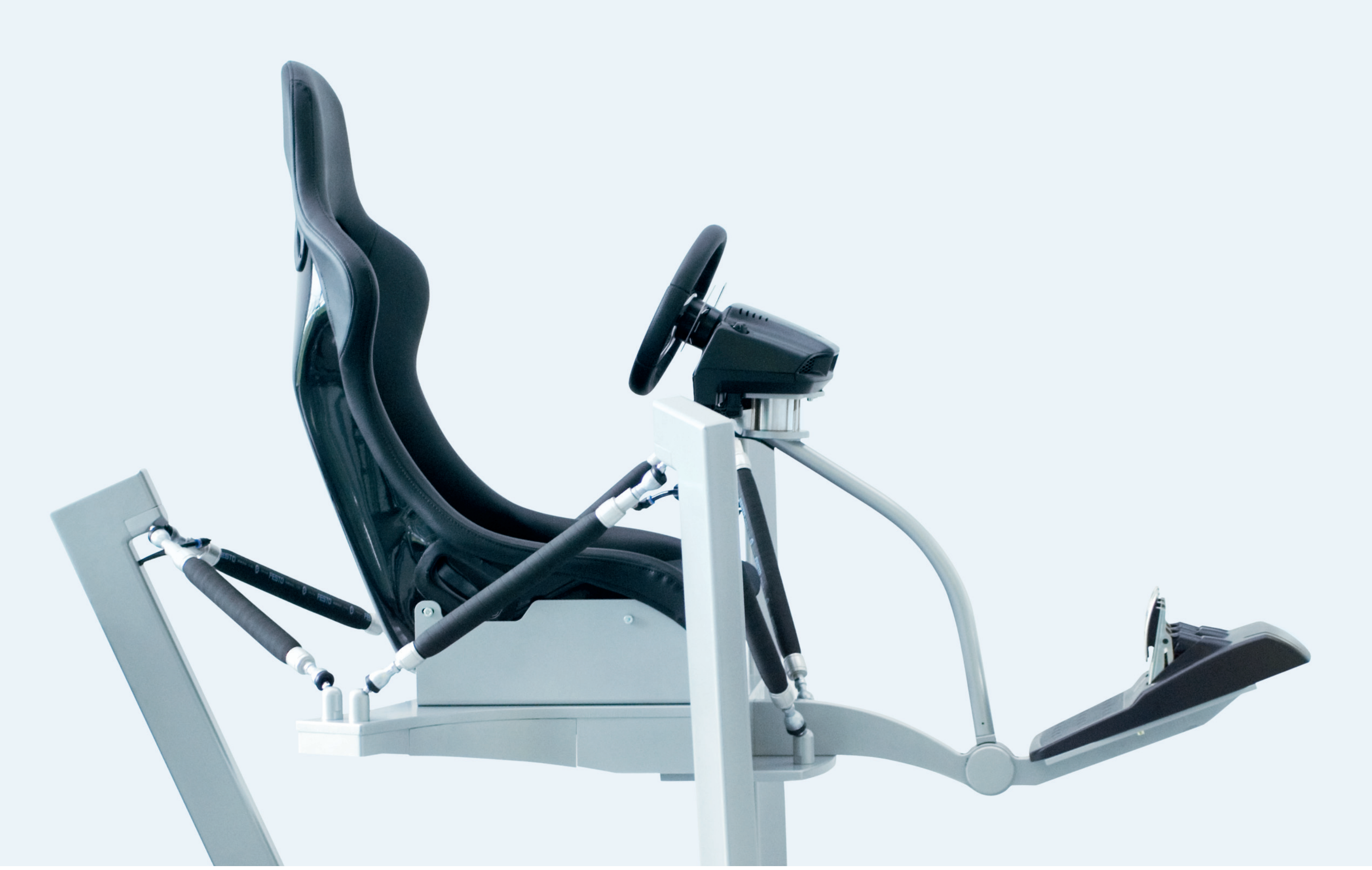


A simulator
moving in 6 axes

Info

Driving and flying with a six-axis full-motion simulator


Simulator

Steering wheel


Pedals

The earliest flight simulators consisted of a pilot's seat attached to a movable platform; its motion resembled that of an aircraft when the joystick is activated. Around 1930, the erstwhile organ-builder Edwin Albert Link developed a full-motion flight simulator, the Link trainer, to reduce the costs of training private pilots. Once he fitted his simulator with blind-flight instruments, it was used by airlines throughout the world for training in instrument flight.

This technology was then further developed to provide realistic simulation of visual flight as well. The field of vision from the cockpit could be generated, for example, by a television camera travelling over a terrain model. Finally, with the introduction of high-power digital computer systems, the images themselves were generated by computer.

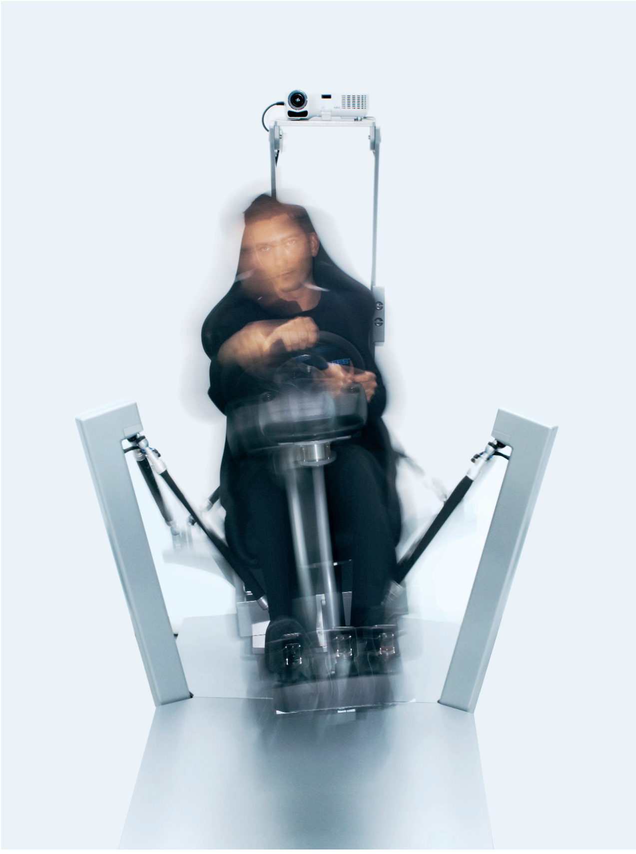
Today, it is no longer sufficient to produce quality high-resolution computer-generated graphics for a realistic virtual world; the physical conditions must also be conveyed to the human pilot. Full-motion simulators, generally moved by hydraulic plungers, are thus now designed as hexapods. These are a special form of parallel-kinetic machine on six legs of variable length. This design allows motion in all six degrees of freedom "translation and rotation in each of the three dimensions". The parallel configuration of the drive units lends hexapods a more favourable ratio of payload to tare weight than with robots acting in series. The hexapod concept was first demonstrated by D. Stewart in 1965.

Like flight simulators, driving simulators can reproduce travel in a specific vehicle by means of projected virtual landscapes and realistic mock-up driver's cabs from public transport vehicles.

The full-motion Airmotion_ride simulator comprises a platform to which a car driver's seat is mounted. This platform, which follows the hexapod structure's movements, is suspended from three steel supports by six pneumatic muscles from Festo. The simulator serves the operator as an interface between the real world and the computer-generated virtual scenario.

The pneumatic muscle from Festo is ideally suited to this suspended hexapod configuration. Thanks to its bionic design, smoothly flowing motion can be realistically simulated. No guide elements are necessary to execute defined movements in any desired direction. This saves weight and, above all, costs. Thanks to its immense starting power, which in the case of the DMSP-20 can generate forces of up to 1,600 N, the lightweight pneumatic muscle is the ideal solution for high-acceleration applications. Since it has no moving mechanical parts, it operates free of friction and even allows movement at very low speeds without sudden jolts or stick-slip behaviour.

With Airmotion_ride, the six degrees of freedom are manifested in independent rotation and displacement of the bucket seat in the three spatial axes. The six required strut lengths are calculated for a given desired position of the seat relative to the frame. The particular challenge consisted in developing this configuration in suspended form with pneumatic muscles. Since the muscles can only exert tractive forces, like natural muscles, the seat must be under load at all times. Sufficient dynamics also had to be provided for control of the seat position, with an appropriate frame design to ensure unrestricted motion.



This was achieved in an iterative development process involving several disciplines of engineering: the frame and seat element were first modelled in CAD. The subjective seating impression was then empirically developed using a prototype. By means of a special simulation system, results from multiple-body mechanics were incorporated into the calculations, so that the forces and movements could be determined at the simulation phase and the construction optimised accordingly. This all-encompassing approach is referred to today as a mechatronic draft.

Six pressure-regulation valves transform the control variables into pressures, and thus into the desired movements. The entire system is controlled with a personal computer. The geometrical data, such as the nominal seat positions, are determined in real time by the respective simulation programmes, e.g. the flight simulator, and converted into six axial values by an interface application. The desired lengths for the contracted pneumatic muscles are then calculated using a hexapod retransformation algorithm.

The scopes of movement and speeds of the six axes are also controlled and regulated.

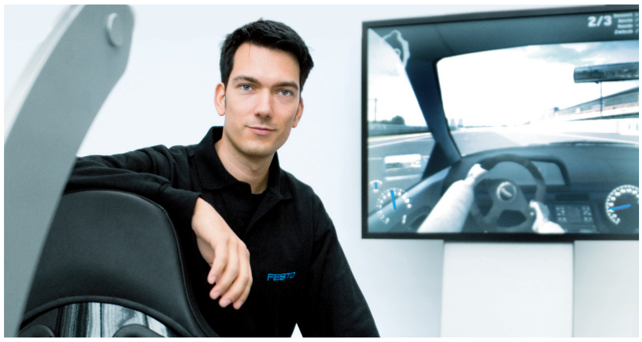
New software solutions or specially devised applications can also be programmed in an open interface using the control software. A profile for the desired simulation is selected; the various simulator movements - pitch, roll, yaw, heave, sway and surge - are then set on the basis of these parameters. There is no restriction on the profile used for each simulation. Airmotion_ride incorporate flight, helicopter, car racing and roller coaster simulations.

The car racing simulator is breaking new ground above all in multi-player applications. Thanks to the excellent network code, bumper-to-bumper duels can be staged either on the Internet or in a local network of up to 23 players, who can drive a wide assortment of cars all based on genuine vehicles.

Flight simulation was originally developed for the aviation industry and endorsed by the U.S. Federal Aviation Administration for the training of commercial pilots. Players can “fly” many different types of aircraft – from a single-engined propeller plane to a supersonic jet or vertical take-off craft, or from a helicopter such as the Bell 206 Jet Ranger to a space shuttle.

The roller coaster simulator catapults the operator to heady heights. Over 40 different circuits and cars are available.

Airmotion_ride’s bionic design has enabled highly diverse simulations to be realised in combination with mechatronic systems. As the leading supplier of pneumatic technology, Festo is demonstrating with this project an exciting, cost-efficient alternative to intricate hydraulic constructions.



Technical data

Simulator	
Length:	176 cm
Width:	127 cm
Height:	166 cm
Pneumatic muscle:	DMSP-20-400NRM
Valves:	MPPES-3-1/4-10-010
Maintenance-free pneumatic drive:	simple operation
Digital surround sound system:	5.1
Force-feedback steering wheel	
Joystick	
Open source system	
Network-compatible	

Project partners

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