

## History – Road Map of Events

The Institute of Flight Research of the German Aerospace Center (DLR, formerly DFVLR) was established in Braunschweig on July 21, 1953 with the rebuilding of the German Aeronautical Research Establishment (DFL) after World War II. DFL later became part of DFVLR (1969). Founding Member and first Director was Hermann Blenk who also became the first President of DFL. Peter Hamel was appointed as Director on April 1, 1971.

**1953**



H. Blenk (right) and Minister of Defense F.-J. Strauß

Foundation of the Institute of Flight Research of the German Aeronautical Establishment (DFL) in Braunschweig.

**1958-1964**



Vertol H 21 research helicopter

Vertol H 21 dynamic response flight tests and rotor blade deformation measurements using a rotorhead-mounted high speed camera-system. The research objectives included a better understanding of rotor aeromechanics and related flying qualities deficiencies.

**1960-1965**



Do 27 research aircraft

Do 27 dynamic response flight tests and flight control augmentation research. Beginning of modeling and parameter identification research.

**1963-1978**

USAF-BMVg/DLR Data Exchange Agreement (DEA): *Subsonic Parachute Design, Performance, and Similarity Laws*. Also research on dynamic pressure loading and effective porosity of canopies. In

total, an exchange of data of 3000 USAF- and 400 DLR-drop tests took place.

### 1963-1983

Large scale flight tests of parachute recovery systems. Development of instrumented drop test vehicles (FB-Family) and personnel dummies. A multitude of flight test programs based on Government contracts was accomplished. In the early eighties, rescue and recovery systems research, development, and evaluation activities of the Institute were discontinued in order to provide manpower for the projected airborne simulator ATTAS.



FB-Family of parachute drop test vehicles



Rocket-boosted test vehicle FB 6 for DEA research

### 1965-1968



Borgward/Focke Kolibri I helicopter prototype

Various helicopter project support activities for the Ministry of Defense and the Federal Certification Agency (LBA) such as flight testing and certification of steel and fiberplastic rotor blades (GFK-blades *System Bölkow*) using a special instrumented Alouette II test helicopter provided by the German Army. Consulting activities included the evaluation of the Borgward/Focke Kolibri I helicopter prototype.

### 1965-1976

Stability investigations and model validation wind tunnel experiments of parachute-payload systems (cooperation with University of Minnesota, USA).

### 1968-1974

Model- and full-scale parachute recovery systems research. Incident and accident research of rescue systems. Analyses, component modifications, ground and flight testing of G 91, F 104, and F 4 rescue systems.



Ground testing of ejection system recovery systems



FB drop test vehicle attached to Fiat G 91 of German Forces Flight Test Center

## 1968-1978

Development and operation of the Free-Flight Parachute Test Facility for parachute experiments in horizontal flight at up to 300 m/s initial velocity.

## 1969-1974



Flight demonstration of a 3K-Parachute system

Development and drop testing of a three-canopy personnel parachute system (3K-System) for low altitudes.

## 1972-1973



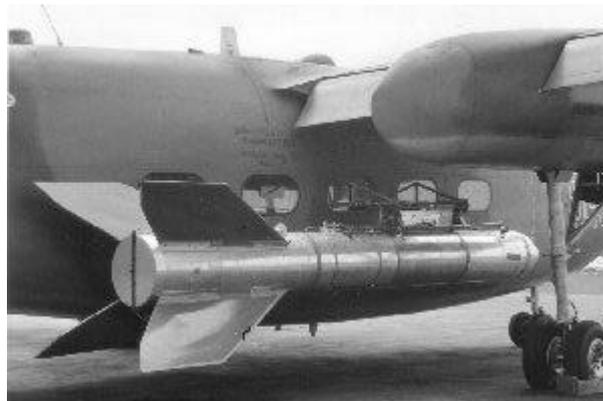
HFB 320 Direct Lift Control flight test aircraft

Design and flight demonstration of an electrically operated Direct Lift Control (DLC) flap system on the HFB 320 (cooperation with MBB).

## 1972-1974



Development and full scale model flight testing of a rocket motor recovery system.

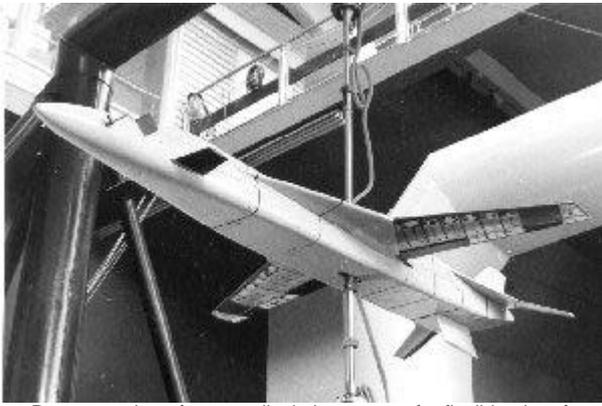


Black Brant rocket motor recovery system test

## 1973

First noise abatement flight test program with HFB 320 test aircraft accomplished. The potential and the decisive effect of precise direct lift control along with automatic throttle control on accurate steep and segmented flight path control was demonstrated.

## 1973-1976



Demonstration of a gust alleviation system for flexible aircraft (Project BASE)

Dynamic wind tunnel simulation of a highly augmented flexible model aircraft with canard control surfaces. The test rig and model aircraft demonstrated open- and closed-loop control laws for variable stability functions, rigid body gust alleviation, and elastic mode suppression systems (Project BASE).

## 1973-1978



Ground testing of a helicopter crew rescue system

Model and full-scale testing of an innovative rescue system for combat helicopter crews. The rescue and recovery process included a "clean" rotor blade severance system (no pyrotechnic cutting debris) and a rocket-assisted crew extraction device.



Ground testing of a helicopter crew rescue system

## 1974

Cooperative Agreement entitled *Wehrtechnische Flugerprobung* signed with the German Forces Flight Test Center BWB/WTD 61. Various collaborative aircraft flying qualities flight test evaluation and parameter estimation programs were initiated since then encompassing the MRCA/ Tornado, Alpha Jet Direct Side Force Control (DSFC) and Transonischer Tragflügel (transonic wing, TST) test aircraft, C-160 Transall, and the EF 2000 Eurofighter. Of national importance was also the formulation of the Flying Qualities Specification Documents for the multinational EF 2000 and the NATO Helicopter NH90 programs. In 1995 the BWB/DLR Cooperation Agreement was revisited and updated.



Dassault/Dornier Alpha Jet DSFC demonstrator aircraft



Dassault/Dornier Alpha Jet TST demonstrator aircraft



German MRCA/Tornado prototype aircraft

**1974-1976**



Model rotor test rig ROTEST in Volkswagen wind tunnel (1976)

Design of a first model rotor test rig for large wind tunnels (ROTEST). First test run accomplished in Volkswagen wind tunnel. It was successively used in the Daimler-Benz and DNW wind tunnels (cooperation with MBB, VFW, and Dornier).

**1974-1998**



USAF and DLR MoU project officers with variable stability aircraft NT-33A

Memorandum of Understanding (MoU) USAF-BMVg/DLR: *Aircraft Flight Control Concepts*. Common simulation and flight test programs with USAF Flight Dynamics Laboratory (FDL) and Edwards Air Force Base and side-by-side located NASA Dryden Flight Research Center undertaken under this MoU. They included direct lift control effects on steep landing approach flight tests at Braunschweig airfield with the HFB 320 DLC demonstrator aircraft supported by an early TALAR MLS flight path guidance system (1976), and pilot evaluations of time delay and reduced stability effects on handling qualities with LAMARS simulator, Calspan NT-33A variable stability aircraft, and the airborne simulator HFB 320 FLISI. GRATE/ATLAS flight test techniques for unmasking handling qualities deficiencies developed and applied to a variety of test aircraft such as NT-33A and X-29 (1984-87).

**1975**

Memorandum of Understanding US Army-BMVg/DLR: *Helicopter Flight Control* established. Since 1986 changed to *Helicopter Aeromechanics*. This MoU will eventually become one of the most successful transatlantic basic research activities in the fields of helicopter flying qualities, flight/ rotor control, noise phenomena, crashworthiness, and unsteady aerodynamics involving US Army, NASA Ames and Langley Research Centers, as well as up to five DLR Institutes at Braunschweig, Göttingen, and Stuttgart Research Sites. German industrial participation is later initiated by ZFL- Kassel and supported by the Institute leading in the year 1993 to the IBC (Individual Blade Control) experiment in the NASA-Ames 40x80 ft wind tunnel facility with a full scale Bo 105 rotor which is controlled by high bandwidth hydraulic actuators designed by ZFL.



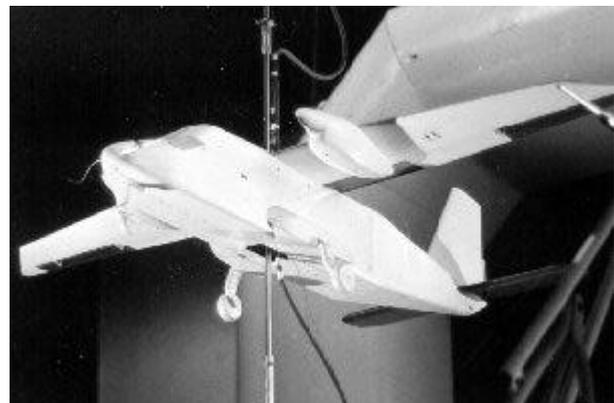
Bo 105 IBC experimental set-up of ZFL in NASA Ames 40x80ft wind tunnel (1993)

### 1976

First publication and flight testing of DLR's 3211 control input signal (*Koehler*-input). The 3211 multistep input is a series of four contiguous steps with alternating signs lasting for 3, 2, 1 and 1 time units. The length of the time unit is adjustable to center the frequency band of the input around the flight vehicle natural frequency. This input signal is relatively easy to fly by pilots and accepted by the international flight test community for parameter estimation purposes.

### 1976-1980

Do 28 TNT flight demonstration of an Open-Loop-Gust-Alleviation (OLGA) system designed for the Do 228 commuter aircraft. This project included a unique and comprehensive correlation and validation process of data from analysis, wind tunnel, and flight test (cooperation with Dornier and IMFL).



Do 28 TNT OLGA wind tunnel model aircraft and flight demonstrator

### 1977



First in-flight simulation with HFB 320 FLISI. This test aircraft was used until 1984 for various flying qualities investigations including effects of direct lift control, reduced stability, and flight control time delays.

In-flight Simulator HFB 320 FLISI with swept forward wing and fl...

## 1977-1978

In-flight simulation of an A310-type wide-body configuration in the landing approach mode with airborne simulator HFB 320 FLISI. First use of a digital model following control law with explicit model calculation.

## 1978



First flight tests with DLR's new research helicopter Bo 105 S-123 for the definition of handling qualities maneuvers, investigation of control strategies, and system identification purposes. Several transatlantic flight test campaigns followed to generate flying qualities databases for future helicopter systems. The complementary use of simulation facilities and research helicopters strongly enhanced the research productivity (cooperation with WTD 61, US Army, and NASA).

Bo 105 S-123 (DLR) and UH-1D(WTD 61) with integrated test team of DLR / NASA / WTD 61.

## 1979

First test entry of modified rotor test rig ROTEST in the large German-Dutch Wind Tunnel (DNW). This was also the first customer-paid DNW test program altogether. Due to its unique aerodynamic and aeroacoustic qualities, it was decided by the Institute to conduct all future rotorcraft model testing at DNW. For this reason a special DNW sting adapter was replicated and integrated in the DLR Test Preparation Facility at the Institute in Braunschweig. Until 1998 about 1500 hours of rotorcraft wind tunnel testing were accumulated.



Floor-mounted rotor test rig ROTEST in DNW (1982)



Advanced rotor blade (LAH) testing in DNW with sting-mounted ROTEST (1989)

## 1981

Launching of VFW 614 in-flight simulator project ATTAS (Advanced Technologies Testing Aircraft

System). The research aircraft was jointly developed with Dasa Bremen and Liebherr Aerospace.

### 1983-1994

Member of Special Research Project (Sonderforschungsbereich) SFB 212 on *Aviation Safety*. During this period, issues pertaining to flight safety and related problem areas were addressed. Excellent rapport and technical contributions paved the way to continuation of the traditional participation since 1995 in a yet another project SFB 420 on *Flight Measurement Techniques*.

### 1984

First vortex-wake aircraft interaction study on request of Frankfurt Airport. Dynamic aircraft response to a perpendicular vortex entry investigated.

### 1984

A new flight test technique GRATE (Ground-Attack-Testing) for unmasking handling qualities deficiencies was developed. It was used at the German Forces Flight Test Center WTD 61 for aircraft flying qualities assessments and pilot training. A derivative dubbed ATLAS was developed by NASA Dryden Flight Research Center and used within cooperative flight test programs with the Institute (Memorandum of Understanding between USAF-FMOD/ DLR) and at the Air Force Test Pilot School, Edwards Air Force Base.

### 1984

Completion of the onboard and ground-based Flight Test Instrumentation System (FTIS) for the Indonesian CN 235 prototype aircraft. This project included a fully equipped autonomous *Container-City* and was accomplished within only 15 months. A multiyear government supported cooperation with IPTN followed including Man Power Development and Training (MPDT) programs, ATTAS in-flight simulation investigations for the N 250 fly-by-wire transport aircraft, and N 250 flight test instrumentation support.



Indonesian prototype aircraft CN 235 (1985)



Meeting with the Indonesian Minister of State for Research and Technology and President of IPTN B.J. Habibie (center), B. Rebe, President of the Technical University of Braunschweig (right), and P. Hamel in the ATTAS Cockpit.

### 1985

First version of a dialog-oriented flight test data analysis package DIVA (Dialogorientierte Versuchsdatenanalyse) tested and implemented. DIVA later became the standard flight data analysis code for flight test engineers at the Institute and partner organizations such as German Forces Flight Test Center WTD 61 and Dasa Flight Test Center, both in Manching. It is used in common projects like X-31A and Eurofighter.

### 1985



In-flight Simulator Bo 105 S-3 ATTheS (foreground)  
Bo 105 S-123 (background)

First in-flight simulation performed with the airborne fly-by-wire/light Helicopter Bo 105 ATTheS (Advanced Technologies Testing Helicopter System). The decoupling of the rigid rotor response of the host helicopter was the most challenging task and rendered feasible only by diligent modeling of higher-order rotor dynamics and the implementation of a high bandwidth model following control system. ATTheS became the only European test facility for rotorcraft in-flight simulation. ATTheS was operated until 1995 with a total of about 1300 hours of digital-electronic flight control experience when the research helicopter was lost during a routine flight.

### 1985



Versatile sting-mounted rotor test rig ROTOS in DNW with advanced rotor blades (1989)

First entry of newly designed modular rotor test rig in DNW. This test rig, later dubbed ROTOS (Rotor-on-Sting), was commonly designed with MBB-UD and incorporates an internal balance, a hydraulic drive motor, and a PCM data acquisition system. ROTOS and an upgraded version will be heavily used in future DNW model rotor test campaigns.

### 1988-1990

Launching, chairing, and managing multinational AGARD FMP Working Group 18 on *Rotorcraft System Identification* comprising a wide range of research specialists and industry representatives. Special Bo 105 flight tests were initiated at the Institute resulting in a world-unique high quality flight data compendium for model validation purposes and flight control law investigations. The outcome of this working group resulted in the preparation of the standard reference documents AGARD Advisory Report 280 and Lecture Series 178.

### 1988

First in-flight simulation accomplished with the fly-by-wire/light aircraft VFW 614 ATTAS. ATTAS is the only European transport-type research aircraft with a flexible nonlinear model following flight control architecture (*Dial-a-Model*). Until 1998 flight experience of about 1200 hours of digital-electronic flight control has been accumulated.



In-flight Simulator VFW 614 ATTAS



Bavarian Ministerpresident (and private jet pilot) F.-J. Strauß testing the ATTAS sidestick (ILA 1988)

### 1989-1994

Member of transatlantic working group for up-grading the Military Helicopter Handling Qualities Specification (ADS-33). These activities provided the basis for the definition of the NH90 Handling Qualities Requirements (1993-1996).

**1990**



German EF 2000 Eurofighter prototypes DA 1 and DA 5

Finalization of the Handling Qualities Definition Document (HQDD) for the EF 2000 Eurofighter. This document was prepared by DLR, WTD 61, and IABG, to become the reference document for all multilateral government handling qualities acceptance flight testing.

**1990-1994**



US-German control technology and post-stall flight demonstrators X-31A

Member of the US-German X-31A Integrated Flight Test Team. The technology demonstrator aircraft X-31A incorporates three-dimensional thrust-vectoring paddles to perform high-angle-of-attack maneuvering in the post-stall flight regime under operational conditions. Responsible for system identification and leading role in designing the separate effector excitation concept for generating physically plausible, reliable, and reproducible simulation models (cooperation with Dasa, RI, NASA, WTD 61).

**1990-1994**

Member of European industrial team for Helicopter ACT (Active Control Technologies). DLR's airborne simulator Bo 105 ATTheS was used as national flight demonstrator for advanced flight control and sidestick technologies.

**1990-1995**



EPNER students gathering with ATTheS safety pilot Klaus Sanders (1990)

Annual test pilot training campaigns with DLR in-flight simulator Bo 105 ATTheS at the French and English test pilot schools EPNER (Ecole du Personnel Navigant d'Essai et de Reception, Istres) and ETPS (Empire Test Pilot's School, Boscombe Down).

**1991**

Organization of the first International Symposium on In-flight Simulation at DLR Research Site in Braunschweig. Display and flight demonstration of In-flight Simulators ATTAS and ATTheS (sponsored by AIAA, AHS, RAeS, AAAF, DGLR, and DLR). More than 100 national and international flight test engineers and pilots attended the meeting and shared with DLR the flight demonstrations of

the airborne simulators.



B. Harper (Arvin/Calspan) during International Symposium on In-flight Simulation after demonstration flight with ATTAS



Formation flight of DLR in-flight simulators ATTAS and ATTheS

**1991**

ATTAS in-flight simulation of Hermes spaceplane. Flight demonstration for European astronauts *Haigneré* and *Reiter*.

**1992-1993**



C-160 flight test team in front of aircraft at German Forces Flight Test Center WTD 61

Instrumentation, flight testing, data-gathering, and model development for C-160 Transall Mission-Simulator accomplished in 15 months. Contract work for Thomson-CSF in cooperation with German Air Force Transport Squadron LTG 62 (Wunstorf) and German Forces Flight Test Center WTD 61 (Manching). A challenging single-engine take-off was demonstrated within the 80-hour flight test program and subsequently modeled for simulation purposes.

**1992**

Unsteady rotor blade pressure measurements and complementary far field BVI (Blade-Vortex-Interaction) noise measurements gathered with ROTOS test rig in DNW. Nearly real-time pressure data analysis in the frequency domain accomplished with innovative TEDAS technology (Throughput Enhanced Data Acquisition System) developed by the Institute. The program was started at DLR (CP-ROT) and transformed to the European Program Helinoise (cooperation with DLR-Institutes of Design Aerodynamics, Aeroelasticity, and Fluid Mechanics, ECD, and Agusta).

**1992**



The champion World Class Glider prototype PW-5 (background) in formation flight with the second placed SZD-51-1 JUNIOR (both from Poland)

World Class Glider prototype assessment. The International Glider Commission of the Fédération Aéronautique Internationale (FAI) organized an international flight assessment. Seven glider prototypes coming from five different nations entered final World Class Glider evaluation. This Institute successfully provided world-unique flight test methodologies and instrumentation for the prototype evaluation of handling qualities and flight performance.

**1992-1995**

Technical project control and supervision, flight vehicle system identification, and flight testing of the high-altitude atmospheric research aircraft G 850 Strato 2C. This world-unique largest carbon-fiber

aircraft with a pressurized cabin and two three-stage turbocharged piston engines attained a maximum altitude of 18500m (world record for manned piston-engined aircraft). Feasibility tests of a Russian emergency pressure suit for long endurance high altitude operations were undertaken in the ATTAS System Simulator (cooperation with Grob, IABG, and various DLR institutes).



High-altitude research aircraft G 850 Strato 2C



Strato 2C pressure suit tests in ATTAS System Simulator

### 1993

Signing of Memorandum of Agreement with Eurocopter provided the first milestone for development of a new Active Control Technology / Flying Helicopter Simulator (ACT/FHS), later dubbed HESTOR, which was launched two years later.

### 1993



Joint flight of airborne simulators Tu 154M and VFW 614 ATTAS as photographed by WTD 61 Alpha Jet.

German-Russian Workshop on In-flight Simulation. Flight Research Institute *Gromov* and DLR Institute of Flight Research made a public display and flight demonstration of their airborne simulators Tu 154M and VFW 614 ATTAS at the Hanover Airport. The Tu 154 M was used for simulating and flight testing the guidance and control system of the Russian Buran spaceplane. In-flight thrust reversing was used to match Buran's low lift-to-drag ratio. ATTAS was also used as reference vehicle for the design specification of the European Hermes Training Aircraft (HTA).

### 1993-1994



NH90 model configuration testing at DNW (1993)

NATO Helicopter Industries NH90 configuration measurements in DNW. Subsequent flight testing revealed no major changes to the NH90 empennage. It is the first time in Europe that diligent wind tunnel tests of complete rotorcraft models were used for development risk and cost reduction of large scale helicopter projects (cooperation with Eurocopter and NLR).

### 1993-1996

ATTAS flight evaluation and validation of advanced control laws dubbed SAFIR (Small Airliner Flight Control Laws Investigation and Refinement). Flying qualities including flight envelope protection functions were rated to be outstanding. Special customer-oriented computer interfaces for hardware-in-the-loop integration were provided by DLR. Results are of direct relevance to the VFW 614 ATD (Aerospace Technologies Demonstrator) EFCS (Electronic Flight Control System) flight test program

planned by Dasa-DA (cooperation with Dasa-DA).

1994



World first autonomous hovering tracking flight demonstrated with ATTheS (1994)

Autonomous hovering tracking flight above moving ground target demonstrated for the first time with Bo 105 ATTheS. High-bandwidth model following flight control for active and effective decoupling of higher-order rotor dynamics is a prerequisite for computer-controlled precision flight. Hands-off tracking flight was achieved by sensor vision and pattern recognition technologies.

1994



Chief test pilot Lelaie and flight test director Robert (both Airbus Industrie) after flight evaluation of very large aircraft dynamics with ATTAS

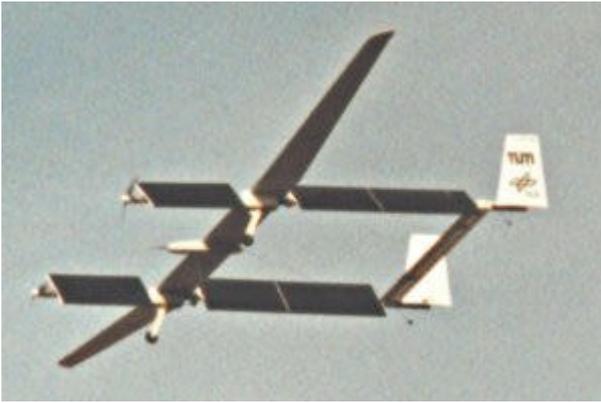
ATTAS in-flight simulation of an A3XX-type very large transport aircraft. Flight control laws based on model following control architectures flight tested and demonstrated (cooperation with Airbus Industrie).

1994



Higher-Harmonic Control Aeroacoustic Rotor Tests (HART) with modified ROTOS test rig in DNW. For the first time unsteady rotor pressure data were gathered under active rotor control test conditions. Minimum vibration and noise control laws explored. Physics of blade-vortex interactions (BVI) studied. TEDAS technology again indispensable for on-line data acquisition and spectral analysis of enormous data quantities. Unique database for aeroacoustic prediction codes (cooperation with US Army, NASA, DLR Institutes of Design Aerodynamics, Aeroelasticity, and Fluid

Transatlantic multidisciplinary active noise control research project

**1994-1998**

SOLITAIR proof-of-concept model aircraft with adjustable solar panels

Development of an unmanned high altitude solar-powered aircraft for long endurance aerial positioning at intermediate latitudes. Flight testing of the SOLITAIR proof-of-concept model aircraft with adjustable solar panels for optimum solar radiation absorption (cooperation with Technical University of Munich).

**1995**

EC 135 host helicopter for the HESTOR (ACT/FHS) project

The Institute (Experimental Flight Control and Measurement System), Eurocopter Deutschland (EC 135 Airframe Modifications and Certification), Liebherr Aerospace (Fly-by-Light Control Actuators and Core Computer) became the key players for system design and integration of the new Active Control Technology and Flying Helicopter Simulator (ACT/FHS) based on a EC 135 host helicopter. This project - later dubbed HESTOR (Helicopter Simulator for Technology, Operations and Research) - is sponsored by the Ministry of Defense (BMVg) and managed by DLR under contract of the German Procurement Agency (BWB). First flight with integrated systems is planned for the year 2000 (additional partners within DLR: Institute of Flight Guidance and Flight Department).

**1995**

Prototype design and demonstration of innovative active pilot control inceptor/sidestick MAGSI (Magnetically force loaded Sidestick, cooperation with Technical University of Braunschweig).

**1995-1997**

ATTAS integrated head-up and flat panel displays

Enhanced and synthetic vision flight tests with ATTAS using head-up and flat panel displays. Flight evaluation and demonstration of an advanced display concept with 3-D terrain presentation on a large flat panel display. In total, 35 flights with 20 airline pilots were conducted at Frankfurt airport. Head-Up Display (HUD) demonstration of low level flights for future large transport aircraft (cooperation with TU Darmstadt, VDO, Dasa, Honeywell).

**1995-1998**

Ground-based (FFA FOSIM) and in-flight simulation (ATTAS) studies of aircraft-pilot coupling (APC) phenomena. Test data were gathered to validate the new DLR stability criterion OLOP (Open-Loop-Onset-Parameter) for predicting pilot-in-the-loop oscillations. Flight critical APC problems are often strongly related to control surface rate saturation effects. The OLOP criterion has already been

applied in national and international aircraft industry projects (cooperation with US NRC, NASA H.Q., FFA, Saab, and WTD 61).

### 1996-1997



Dornier 328 commuter aircraft

Mathematical model development for Dornier 328-110 Level-D Training Simulator. Reversible manual flight control dynamics and propeller slipstream interference effects challenged the complex nonlinear modeling and validation process. FAA Level-D certification was achieved (cooperation with Fairchild/Dornier).

### 1996-1999



ALEX I system during take-off beneath research helicopter Bo 105 S-123

Development and flight testing of a Small Autonomous Parafoil Landing Experiment (ALEX) for the investigation of GNC concepts for autonomous landing. Research focuses also on low-cost instrumentation and system identification of non-rigid parafoil-payload systems (cooperation with Technical University of Braunschweig).

### 1996-1999

Development support for the VFW 614 ATD (Advanced Technologies Demonstrator) of Dasa-DA. ATD is the attempt of the German Aerospace Industry to develop, flight test, and certify a full digital fly-by-wire flight control system without mechanical back-up. The Institute provided scientific and engineering support regarding handling qualities analysis, flight control law design, sensor calibration, telemetry setup, and flight test preparation.



VFW 614 ATD Fly by Wire Technology Demonstrator



W. Kröll, Chairman of the DLR Executive Board (right), and G. Schröder, Ministerpresident of Lower Saxony, now Chancellor of the Federal Republic (center), being briefed on HESTOR (ACT/FHS) host helicopter EC 135 (1997)

**1997-1998**



High altitude research aircraft Grob G 520T Egrett in Oberpfaffenhofen

Flight test program for airborne sensor integration and system certification conducted for the high altitude research aircraft Grob G 520T Egrett twin-seater, owned by the Flinders University/Airborne Research Australia. The flight test program was managed by the Institute, accumulating a total of 24 flight test hours. Aircraft testing included flutter, stability and control, and climb performance checks. A maximum operational ceiling of 50100 ft pressure altitude was achieved.

**1998**

Consolidation and finalization of a modular system of algorithms for parameter estimation. This unique tool, dubbed ESTIMA is used in all Institute's projects on flight vehicle system identification. The first version of the software tool for parameter estimation for general nonlinear systems was developed in the period 1981-1983. Later, in 1989 the techniques were extended to account for plant noise (atmospheric turbulence).

**1998**



Bo 105 S-1 IBC technology demonstrator and DLR flight test engineers

IBC (Individual Blade Control) flight tests accomplished with ZFL actuator technology integrated into the Bo 105 S-1 technology demonstrator of Eurocopter Deutschland. DLR provided control law design, PCM instrumentation as well as data acquisition and evaluation systems.

**1998**

15 years of fruitful collaboration between the Institute and NAL (National Aerospace Laboratories, Bangalore, India) covering the fields of system identification, data analysis, flight control system design techniques, and flight instrumentation. The 10th anniversary of cooperation was celebrated in November 1993 with a joint symposium on System Identification. The cooperation led to an exchange of more than 20 scientists from each side. The Institute was also the host organization for Indian DAAD as well as *Alexander-von-Humboldt* fellowship holders.

1998



US Army, BMVg and DLR team members at 20-Year-MoU-Anniversary celebration meeting in Bonn.

The 20-Year-Anniversary of the US Army-BMVg/DLR Memorandum of Understanding (MoU) in *Helicopter Aeromechanics* was celebrated at the German Ministry of Defense. US and German government representatives commended to this MoU as a shining example of successful transatlantic cooperation in the field of fundamental and multidisciplinary aeronautical research. The complementary use of research tools, and the work in integrated teams produced world-unique results which a single party could not have accomplished.

1998

ATTAS *Dial-a-Model* demonstration flights for ETPS and EPNER test pilot schools. With these flights, the Test Pilot Training Syllabus was established and consolidated. ATTAS will be flown for ETPS, EPNER, and the German Forces Flight Test Center WTD 61 as test pilot training aircraft in 1999 and following years.

1998

DLR-ONERA installation of a permanent rotorcraft management team. The cooperation was pioneered by the Institute, defining three leading projects dubbed *Quiet, Smart, and Robust Helicopter*.

1998



ERATO and the people in DNW

A new low noise, high performance rotor system named ERATO was commonly developed by DLR and ONERA. Extensive computations with varying local rotor blade parameters like airfoil section, chord, and sweep and twist angles resulted in an unconventional noise alleviating blade shape. The rotor was successfully tested in the Modane wind tunnel and at DNW (cooperation with ONERA, Eurocopter, and DLR-Institutes of Design Aerodynamics and Aeroelasticity).

1999

Within the program to expand the FBW-flight regime of the In-Flight Simulator ATTAS for research application to touch down and landing first FBW- landing took place on April, 30 at Berlin Schoenefeld airport. Several technical modifications have been developed to allow safe operation also in failure cases near the ground.

1999

A flight test campaign with ATTAS was carried out under contract of the French Test pilot school (EPNER) at Istres May 1999. ATTAS in the role as In-Flight Simulator was used to demonstrate to the test pilots various aircraft/ flight control characteristics mainly for large transport aircraft. The tests include rate-, nz- and alfa-command control, one engine approach and virtual ILS-approach.

1999

The name of the  
**DLR - Institute of Flight Mechanics**  
has been changed on 17. December 1999.

The new name of the institute is  
**DLR - Institute of Flight Research**

**2000**



The active sidestick development MAGSI was completed end of 2000. The system with an unique electromagnetic actuation system is scheduled to be flight tested on ATTAS in the EPIAS program (Enhanced pilot information by using active sidestick) to investigate the influences of tactile information in order to improve situational awareness of the pilot. In total seven units were built.

**2000**

Within the ATTAS up grade program the system capabilities were improved to fulfill present and future requirements. In 2000 a new high performance VME-bus based experimental control computer (EXEC) as well as DMA interfaces to link user hardware were integrated and operated on ATTAS. Further, a new user software interface based on MATLAB/SIMULINK was established. This solution allows autocoding of the SIMULINK designed programs by using the Real Time Workshop to real time programs running on the ATTAS target computers. This new approach allows very simple and safe transportation of user developed software into the flight test bed.

**2000**



The ground based system simulator for ATTAS got a new improved vision system. The system has two channels with video projection of 120 degrees in azimuth and 30 degrees in elevation. Further terrain data base was improved to provide detailed Frankfurt and Braunschweig airport sceneries for landing tests. The ATTAS simulator has to be used to verify user software, to prove flight test procedures and to train the crew before the real flight test.

**2000**



The ACT/FHS helicopter simulator in the same role as the ATTAS simulator was completed for testing the experimental fly-by-wire equipment and functions before installed in the flight test vehicle.

**2000**

Flight test engineer training on ATTAS was carried out at Braunschweig, Sept. 2000 under contract of the Empire Test Pilot School. Uk (ETPS). The training objective was to demonstrate the behaviour of augmentation systems in-flight which were designed by the test engineers. After flight demonstration the engineers could improve their design on the base of SIMULINK. Next day the modified systems could be flight tested on ATTAS for further evaluation.

In total 5 engineers, one testpilot and two tutors took part on the flight trials where 9 control configurations were tested.

**2001**

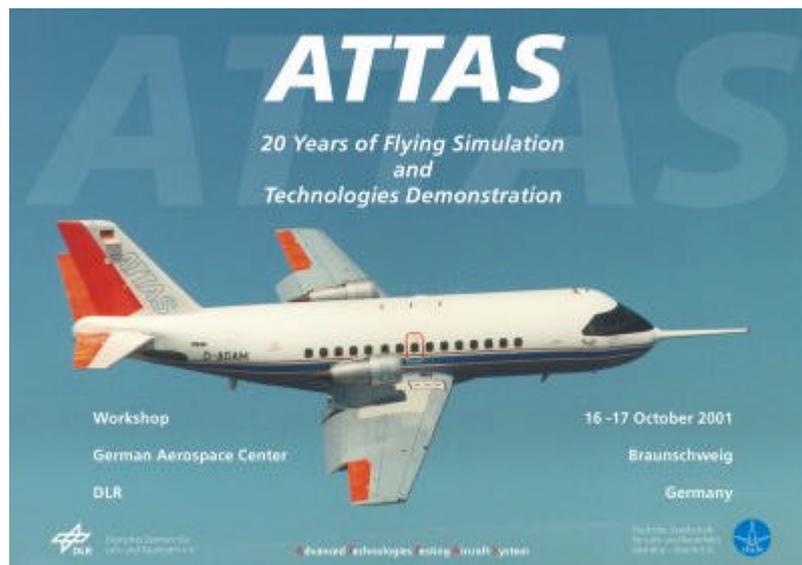


The former and the new Director of the Institute of Flight Research, Prof. Peter Hamel (left) and Prof. Stefan Levedag, having a chat at the ATTAS 20 Year Anniversary Workshop.

On 16 August 2001 during a farewell celebration Prof. Dr.-Ing. SM., Peter Hamel was honored for his successful leadership of the Institute of Flight Research during more than 30 years. Prof. Hamel retired on 1 August. The new director is Prof. Dr.-Ing. Stefan Levedag.

## 2001

On the occasion of the 20th anniversary of the In-Flight Simulator and Flying Demonstrator Aircraft ATTAS (Advanced Technologies Testing Aircraft System) a scientific workshop was held at the DLR Research Center Braunschweig on October 16th and 17th 2001. For this important event 60 international flight testing experts came together. The unique capabilities and the most important flight test campaigns carried out on ATTAS over the last 15 years were presented by DLR scientists and ATTAS customers. The high-light at the end of the workshop was a demonstration of the three testing facilities: The ATTAS aircraft, the ATTAS ground based simulator and the ATTAS rear cockpit.



## 2001



His Excellency Mr. Ronen Sen (right), Ambassador, Embassy of India, releasing the brochure.

The 20<sup>th</sup> Anniversary of the DLR-NAL (National Aerospace Laboratories, Bangalore, India) bilateral cooperation for peaceful purposes in the field of Aeronautical Sciences was celebrated at the Embassy of India in Berlin on 25-26 Sept. 2001. The One-Day Technical Symposium was part of the celebration and essentially organized to take stock of the major R&D activities pursued jointly in the different areas, the achievements and to plan future directions. During the last 20 years different DLR Institutes (Flight Research, Aerodynamics and Flow Techniques, Structure Mechanics and Flight Guidance) were involved in this cooperation. The complementary use of software tools and wind-tunnel test techniques produced some unique

results. A detailed brochure giving an excellent record of highlights of joint work carried out by DLR-NAL Teams over the years was compiled and released during the celebration. Besides the outstanding technical results and large number of peer reviewed international publications, the unique feature of the cooperation program was the excellent understanding and close rapport amongst the collaborators at various levels.

**2002**