“DLR Project Cancelled”

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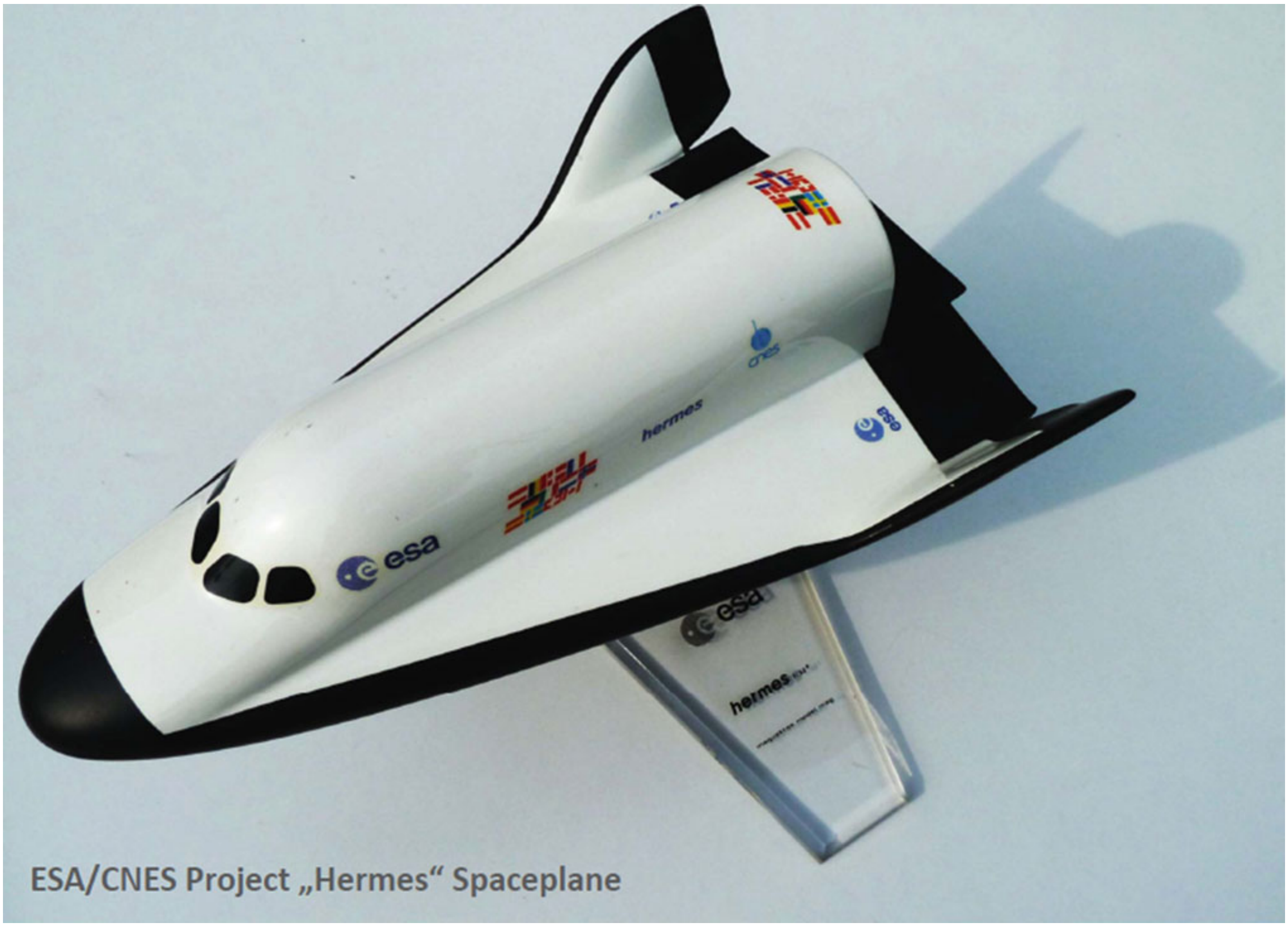
Peter G. Hamel



11.1 Introduction

The term “Project Cancelled” acquired a special meaning in British aviation history during the postwar period. In a critical documentation (see Fig. 11.1), the British doyen of investigative aviation journalism, *Derek Wood* vividly

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P.G. Hamel (ed.), *In-Flight Simulators and Fly-by-Wire/Light Demonstrators*,
DOI 10.1007/978-3-319-53997-3_11

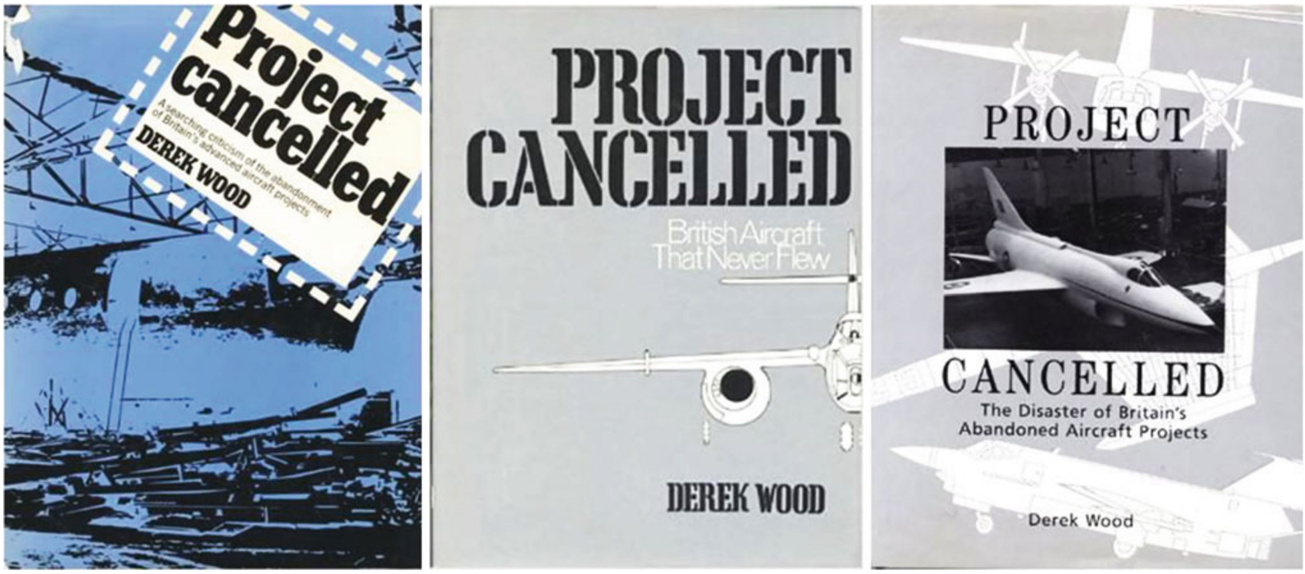

Fig. 11.1 Book title "Project Cancelled" in various versions

portrayed how the wrong political decisions ushered the downfall of the once leading British aeronautical industry [1]. This included the termination of the Miles M.52 supersonic project on January 31, 1946, the discontinuation of the Saunders Roe SR.177 fighter aircraft development based on the successful SR.53 in 1957, and the abandonment of the then world's most advanced Fly-by-Wire supersonic interceptor BAC TSR-2 in 1965.

The British were particularly incensed about the fact that the complete know-how of the Miles M.52 project equipped with a thin, straight wing and provided with a sharp leading edge ("Gilette") was made available to the United States for their supersonic project Bell X-1 (see Fig. 11.2). A variety of technical innovations were to be incorporated in the M.52. A key element was an all-moving tail plane ("flying tail"), which became necessary for an effective flight control in the supersonic range due to a large shift of the center of pressure. It differed from the traditional tail design with horizontal stabilizer and hinged elevator. Without this British know-how, the world's first successful supersonic flight of XS-1 on October 16, 1947 may not have become possible so quickly. As justification for the M.52 project discontinuation, *Sir Ben Lockspeiser* quoted the German knowledge about the advantages of swept wing for high-speed flight. A year earlier he had visited the Aeronautical Research Institute (LFA) at Braunschweig-Völkenrode after the collapse of the Third Reich. In the year 1977, when enquired about the root causes of M.52 project termination, *Sir Ben* replied: "*old men forget*" [2].

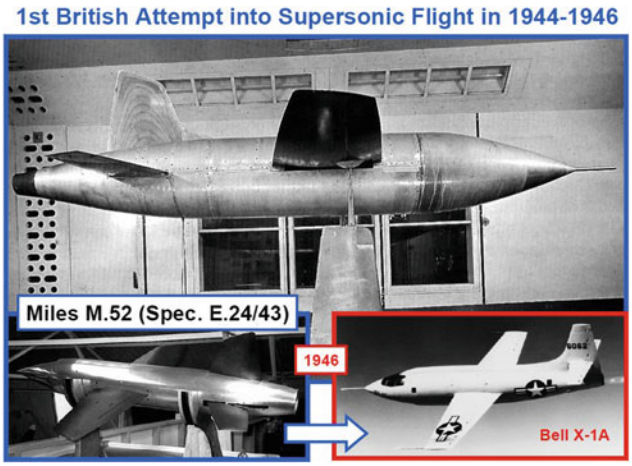

Fig. 11.2 British know-how transfer to USA

The termination of the SR.177 project, shortly before its first flight in April 1958, was also attributed to a blatant misjudgment of future air defense requirements. In a White Paper, defense minister *Duncan Sandys* issued the statement that the English Electric Lightning (see Fig. 11.3) would be the last manned interceptor ("*No more manned aircraft*"). As a result, the SR.177 variants, which were planned for the Canadian and German Air Forces, were also terminated (see Fig. 11.4).

Also the BAC TSR-2 Fly-by-Wire project, at that time technologically most advanced in the Western world, was a victim of political conflicts (see Fig. 11.5). Despite the

Fig. 11.3 English electric lightning

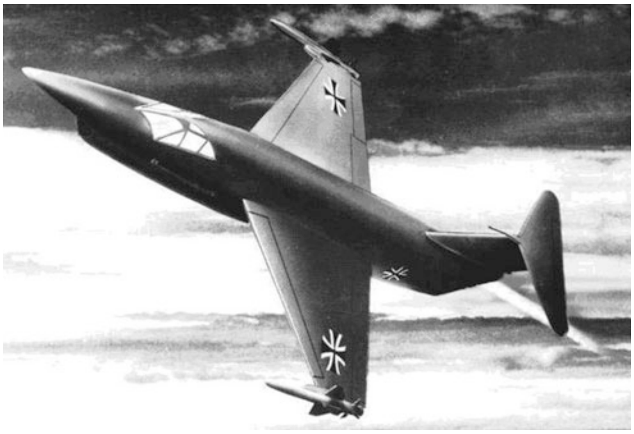

Fig. 11.4 SR.177—planned for German Air Force

Fig. 11.5 BAC TSR.2 first flight takeoff on September 27, 1964

ongoing successful flight testing (first supersonic flight on February 22, 1965), the project was discontinued by the newly elected Labor government in April 1965. The defense minister of the Labor government *Dennis Healy* was quoted as follow: "*The only way to make money in the aircraft industry is never to produce an aircraft* [3]".[1]

It resulted in mass layoffs of highly qualified engineers who migrated to other industries or emigrated to North America. The cost-saving alternative planned by the Labor government, namely the purchase of the US-American variable geometry swing wing aircraft General Dynamics F-111K, resulted in another disaster leading to contract termination due to serious technical deficiencies.

As a final result, a McDonnell F-4 Phantom-version from the United States was selected with British engines (RR Spey), which was characterized by particularly high maintenance efforts as "*hodgepodge*" aircraft (patchwork aircraft).

Like the British industry, the German aeronautical industry too dealt with projects which were either not realized or did not reach the flight test stage in the 60s and 70s, because the military-political scenarios had changed. Accordingly, all of the vertical takeoff demonstrator programs VJ-101, Do 31 and VAK 191 (see Sect. 6.1.3.1) were abandoned, after a thorough flight test phase in cooperation with the United States.

These events on the British side were dramatic and the consequent dependence of England on the United States in aviation policy matters was tragic. Comparably interesting are the unrealized project-initiatives of DLR in the field of Fly-by-Wire technologies and in-flight simulation, which are elaborated in the following Sects. 11.2 through 11.5.

11.2 DLR/Dornier AlphaJet CASTOR (1984)

In March 1984, together with its partners Dornier (*H. Max*, *H. Wünnenberg*), BWB AFB LG IV (*R. Rosenberg*) of the Federal Office of Defense Technology and Procurement (BWB), WTD-61, the German Air Force Flight Test Center, and the Institute of Flight Mechanics DFVLR compiled a proposal for the development of an in-flight simulator for combat aircraft (see Fig. 11.6). Based on the Alpha Jet prototype P 03, the Fly-by-Wire test aircraft—abbreviated CASTOR (*Combat Aircraft Simulator for Training, Operations, and Research*)—was to serve the purposes of pilot training, development and integration of new flight control and display technologies, and the assessment of flying qualities.

The partners were convinced at that time that the development of a digital-electrical flight control system for a variable stability aircraft and the conversion of an appropriate test vehicle to an in-flight simulator would be an important cornerstone for the future collaborative work. It would have been at the disposal of German Air Force, aeronautical industry and the German Aerospace Research Establishment (DFVLR). As there was no comparable airborne combat aircraft simulator in Europe, the interest of NATO partners was foreseen.

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[1] See [2], pp. 219–229.

BWB Erpst. 61

DORNIER DFVLR

CASTOR

ENTWICKLUNG
EINES FLIEGENDEN SIMULATORS
FÜR KAMPFFLUGZEUGE
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Fig. 11.6 Alpha Jet CASTOR scope proposal

The various anticipated tasks were grouped into two elements as follows: (1) systems engineering investigations to reduce the developmental risks in new flight control and guidance concepts and (2) pilot familiarization and training. The experience at Dornier and BWB LG IV, gained during the development and testing phase of direct force controller (DFC), provided a sound knowledge base (see Sect. 6.3.5). Furthermore, all necessary knowledge pertaining to systems engineering control system design, software development as well as experimental and evaluation procedures was available at DFLVR based on decades of experience in the field of in-flight simulation. Also, important know-how related to electrical flight controls and safety concepts (redundancy requirements), acquired by MBB as a part of the F-104 CCV program, could have been directly utilized in the CASTOR program (see Sect. 6.3.4).

Accordingly, the DFC system integration and evaluation were to be carried out in the first phase of the Alpha Jet P03 development project. Integration of special equipment for the in-flight simulation was planned in the second phase. The total cost for this last stage was estimated to be about 25 million DM [4].

While the individual DFC components could be implemented and tested in the first phase, the overall project had to be abandoned due to inadequate financial resources (see Sect. 6.3.5).

An interesting aspect in this context was another option of Alpha Jet utilization for civilian purposes. As a part of the European Hermes Spaceplane project, besides the Hermes Training Aircraft (HTA) based on a Dassault Falcon 900 or Grumman Gulfstream IV, an Alpha Jet with minor modifications was also contemplated as a Trajectory Training Aircraft (TTA) for “fitness training” of the astronaut-pilots (see Sect. 11.5).

11.3 DLR/MBB BK 117 HESTOR (1984–1986)

Envisioning future military and civilian rotorcraft to be fitted with Fly-by-Wire flight control systems on a regular basis, there was an increasing demand for the design and testing of rotorcraft control augmentation systems. For this purpose, supported by MBB UD (today: Airbus Helicopters, Germany), the DFVLR (today: DLR) Institute of Flight Mechanics (today: Flight Systems) conceptualized an in-flight simulator HESTOR (*Helicopter Simulator for Technology, Research and Operations*) based on a BK 117 helicopter (today: Eurocopter/Airbus Helicopters EC145/H145 in different variants). Accordingly, a proposal was put forward jointly with MBB (see Fig. 11.7) [5].

The research objectives of the HESTOR project were to obtain, under real operational conditions, reliable and generally valid evidence about the future helicopter flying qualities and system characteristics for (1) new and extended flight missions and (2) integration of new key technologies such as intelligent sensors, computer and actuation systems, and advanced displays and control devices (sidestick). At DFVLR, an in-flight simulator Bo 105 ATTHeS was already in operation for basic research purposes (see Chap. 8). The experience and knowledge gained with this testbed, particularly in the field of Fly-by-Wire/Light flight control technologies were to be utilized in the HESTOR project. ATTHeS was hitherto the only European helicopter in-flight simulator and this situation was to be extended through the acquisition of HESTOR.

BK 117 was one of the most modern helicopters with (1) an advanced hingeless rotor system with exceptionally

MBB DFVLR

HESTOR

ENTWICKLUNG
EINES FLIEGENDEN SIMULATORS
FÜR HUBSCHRAUBER
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Fig. 11.7 BK 117 HESTOR framework proposal

good control response, (2) high power reserves for testing in an extended flight regime, and (3) large installation space for test equipment and for implementing two independent experimental cockpits. High component reliability and low maintenance cost were further important features of the helicopter. Also, the BK 117 was produced in sufficient quantities and served particularly successfully the air rescue market [6].

The HESTOR project proposal was based on the objectives of the German Working Group on Helicopter Technology AKH (Arbeitskreis Hubschrauber Technologien) being sponsored by the Federal Ministry for Research and Technology (BMFT). In a meeting with BMFT on April 22, 1986, it was agreed that DFVLR would lead the project in cooperation with MBB-UD and the Federal Ministry of Defense (BMVg). In the meantime, financing models were discussed, which also took financial participation of industry and DFVLR into account.

Meanwhile, the US Army had several times clearly expressed their interest to procure a virtually identical helicopter in-flight simulator under the existing MoU (Memorandum of Understanding) between Germany and the United States in the area of Helicopter Flight. The starting point of this US interest was the impressive comparative flight testing of the BK 117 with various helicopters of the US industry. Thereby the BK 117 excelled particularly due to its high maneuverability. Even good flying qualities were attested for aerial combat. Furthermore, a solid cooperative basis for such a project was established by the years of successful joint research between the Aeroflightdynamics Directorate of the US Army, the NASA Ames Research Center and the DFVLR Institute of Flight Mechanics in the field of in-flight simulation of rotorcraft. (see also Sect. 12.3.3). Of course, the concerted procurement of two HESTOR helicopters would have been also extremely attractive for cost reasons.

In spite of that, the well-prepared and promising project proposal failed because ultimately the common willingness of the management in research, industry and government departments lacked the commitment to undertake such a project. For nearly 10 years the project name HESTOR haunted still the DFVLR offices. Finally, the Institute of Flight Mechanics successfully managed to realize a helicopter in-flight simulator, now based on an EC 135. This time, the course was set right by the clear terms on the part of the BMVg and by the stipulated MoA (Memorandum of Agreement) on November 2, 1993 with the former French development director *Yves Richard* (see Fig. 8.36) of Eurocopter S.A. (today: Airbus Helicopters). This time an optimal constellation of personalities and decision makers was found to realize such a project. This included besides *Ives Richard* from Eurocopter, *Rolf Schreiber*, the former Deputy Section Head in the Federal Ministry of Defense (MoD), *Wieland König*, Head of Helicopter Department at the Federal Office of Defense Technology and Procurement (BWB) and later director of the German Flight Test Center (WTD-61), and *Heinz Max*, former Dornier development director and Program Director for Aeronautics at DLR (see Chap. 10).

11.4 DLR BK 117 Tele-Hestor (1986)

Considering the aforementioned HESTOR project, once again based on a DFVLR initiative, the BMFT Working Group on Helicopter Technology (AKH) had recommended

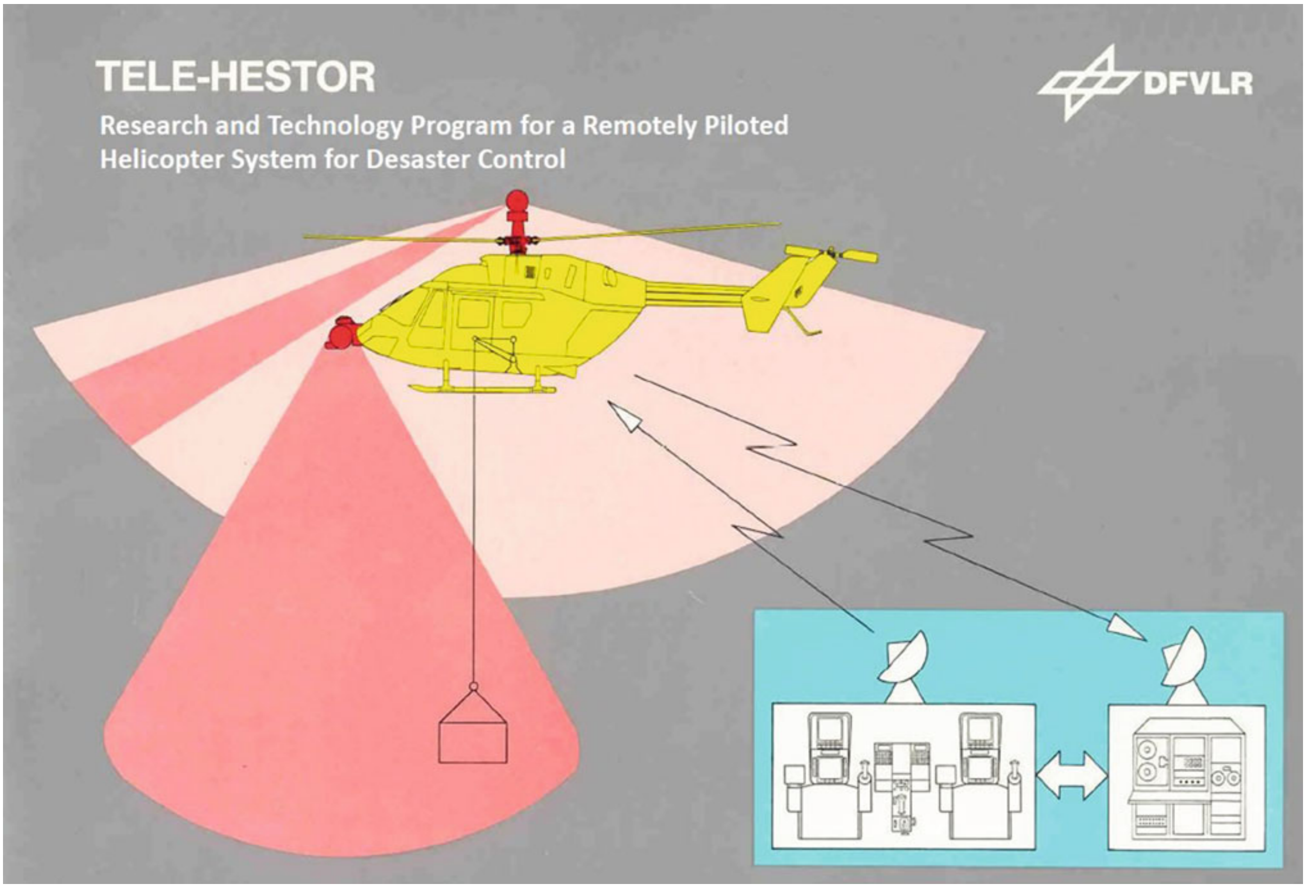

Fig. 11.8 Project proposal TELE-HESTOR

in a Meeting on July 10, 1986, to rehash the utilization potential of a HESTOR technology demonstrator for the development and operationalization of new technologies for disaster management. The Institute of Flight Mechanics of DFVLR then submitted a memorandum that was essential for the realization of a powerful, unmanned helicopter system (Telecopter) for disaster prevention and protection measures (see Fig. 11.8 [7]). The required integration issues of various high-technology areas were elaborated therein.

Telecopter missions were aimed at extending the operation-flexibility of tele-operator systems for disaster management and control (see Fig. 11.9). They included missions in hazardous, emergency and disaster areas at high risk for human beings. They included tasks for reconnaissance and monitoring, damage control as well as rescue and recovery operations. The Telecopter should be remotely flown by a "mission pilot", who manipulates in a mobile ground control station at a sufficiently safe distance from the actual place of operation. All of the visual and flight status information, required onboard the Telecopter by the mission pilots, should be gathered by exclusive sensor systems such as electro-optical sensors for all-weather conditions and transmitted via image processing and telemetry data links to the ground control station. The determination of exact positions should be provided by satellite navigation, and the control of the Telecopter via command links (see Fig. 11.10).

The Telecopter should be operated by a "mission operator" in the ground control station, who remotely operates the sensor and manipulator systems as required, for example by aligning video cameras, activating measurement systems, and dropping and lifting of loads. To meet the high standards of flight safety in European airspace, the remotely operated Telecopter will be monitored during training missions by an onboard safety pilot. Many years of experience at DFVLR in the operation of in-flight simulators with safety pilots would thus be of particular importance.

The technology demonstration program TELE-HESTOR was planned for testing the essential technologies for a future Telecopter system employing large payloads over sufficient

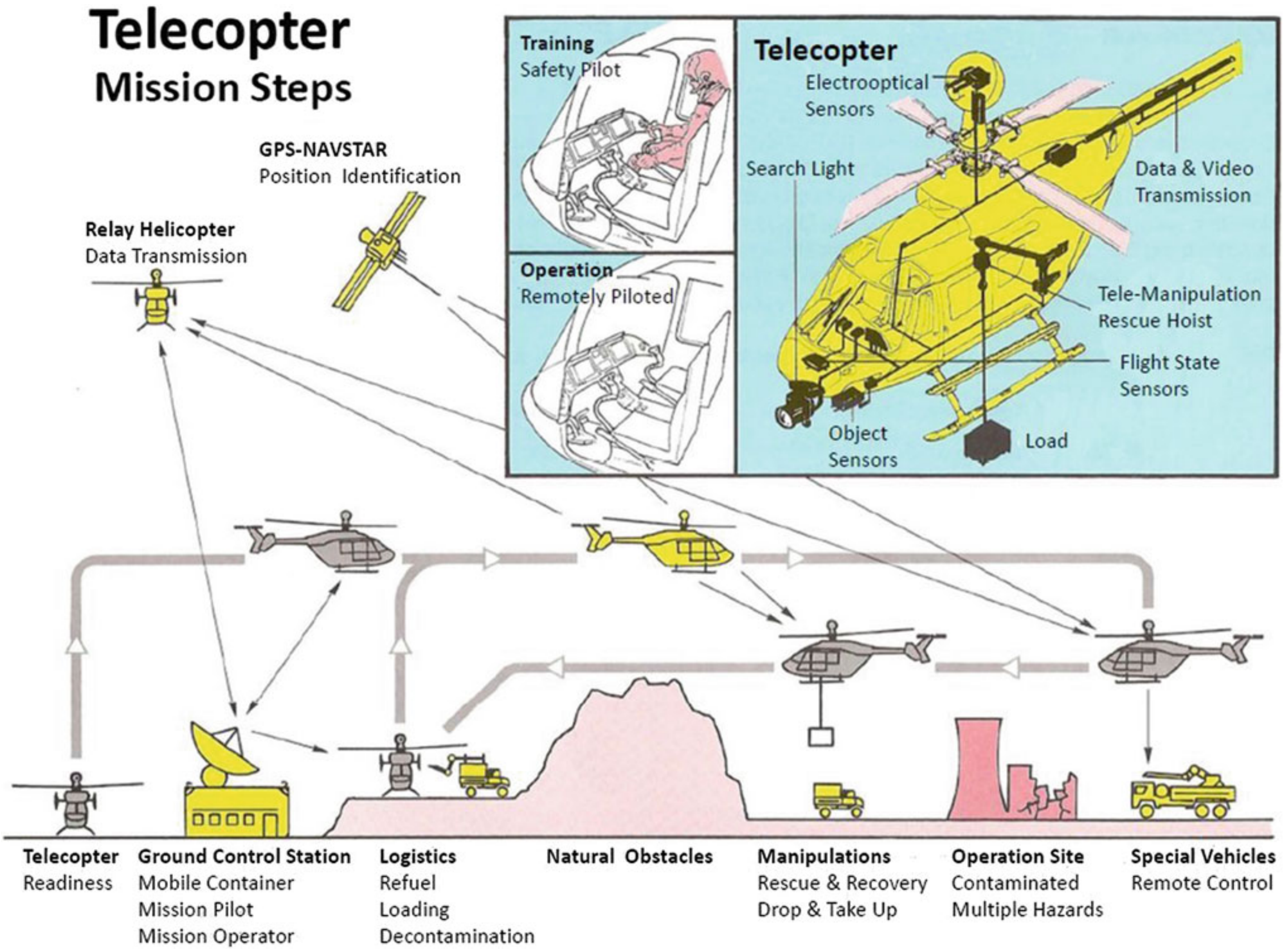

Fig. 11.9 Tele-operator systems for disaster management

ranges (minimum requirements: 1 ton, 400 km) and with an ability to carry out highly accurate remote operations such as reconnaissance and measurement missions. Besides technologies such as high-precision sensor systems for determining flight conditions and environmental variables, ruggedized robust computer systems and robust electro-optical flight control systems, an emphasis was placed on planning and optimizing the human-machine interface A further focus was on the information technologies and robotics as important components of the overall experimental TELE-HESTOR system.

The TELE-HESTOR testing concept included the in-flight simulator BK 117 HESTOR as a key element (see Sect. 11.3). Research objectives would have been to evaluate and optimize the pilot-helicopter interface through smart control devices, displays and computer support under operational conditions. A mobile control station was envisaged with workstations for the mission pilot and mission operator (see Fig. 11.11). High technological demands were placed on the visual information, which necessitated integrated electro-optical sensor systems, capable of alignment, for day and night utilization and all-round visibility. The displays were to be either with high-resolution color multi-functional and panorama screens or directly in the field-of-view by head-mounted displays. Wide vision fields for peripheral motion cues and sufficient visual depth (3D detection and object or obstacle recognition) are essential human perceptional parameters for carrying out remotely piloted helicopter missions. Another important issue was the disturbance free

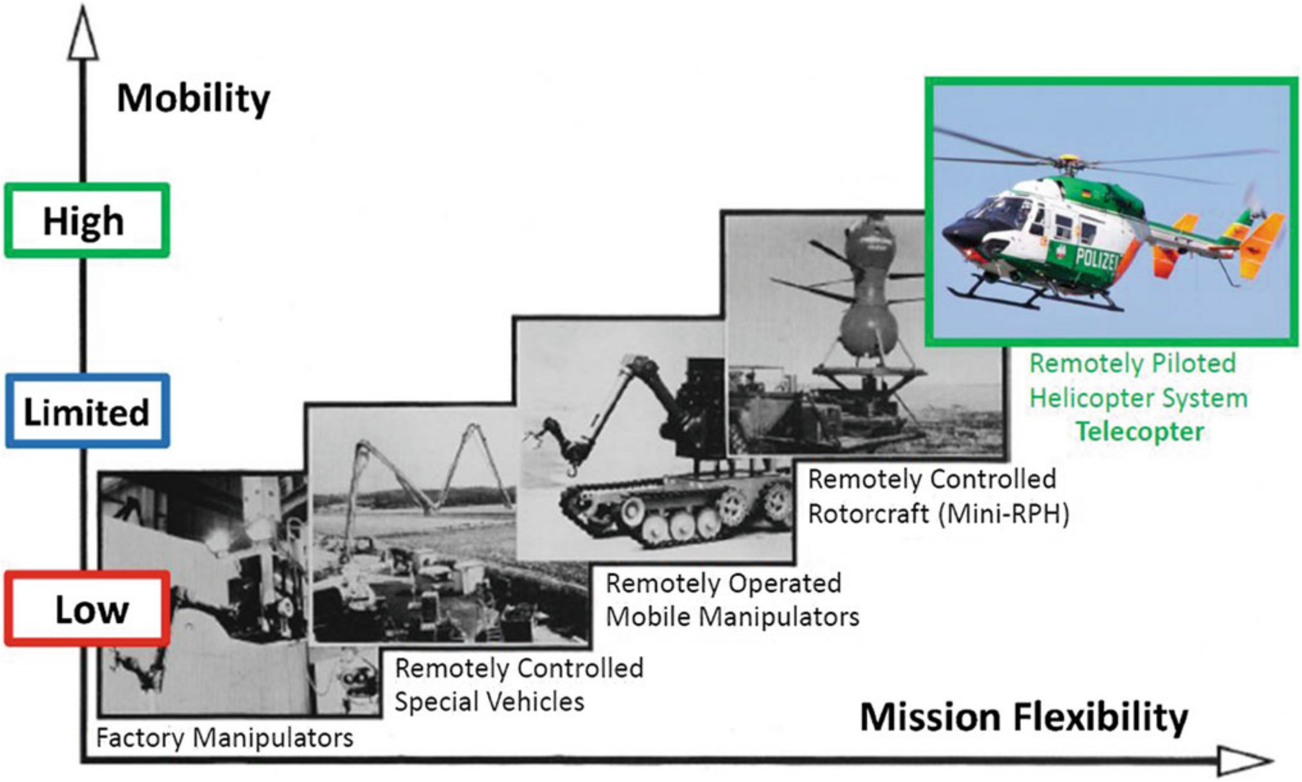

Fig. 11.10 Telecopter—operational profile

and reliable transmission of images and flight data in real time as well as of the command signals for remotely directing and manipulating the TELE-HESTOR platform.

Three implementation steps were planned for the TELE-HESTOR program, that was aimed at successive transfer of the onboard workstations to the ground control station (see Fig. 11.12). With the configuration 3/0, missions were planned with the fully manned in-flight simulator HESTOR, that is, with a safety pilot, mission pilot, and operator. The focus of the investigation was to be on the selection, integration, and evaluation of onboard sensor systems and on the optimization of crew interaction and coordination issues. Data gathering and analysis of flight and environmental data, as well as that of the mission equipment, were to be carried out on the ground.

With the configuration 2/1, the mission operator workplace should be shifted from the helicopter to the mobile ground control station. The scientific investigations should be focused during this step on the adequate visual cues for remote manipulations and expert systems to relieve the mission operator.

In the configuration 1/2, only the safety pilot should be onboard to enable a safe flight operation. Realistic flight tasks for actual disaster prevention were to be carried out remotely-manned from the mission pilot workplace. Thereby special attention is focused on the flight mechanical issues, such as controller-based adaptation of handling qualities of the remotely-manned helicopter to the skills of the mission pilot working on the ground under limited visibility and motion cues. Finally, complete remote-operator-missions were to be tested with this configuration.

Because the HESTOR-Project had not received additional public funding, even this highly regarded TELE-HESTOR project initiative had to be abandoned in 1986. More than 20 years later, US rotorcraft companies like Boeing and Sikorsky picked up an equivalent concept for a variable manned helicopter system and even patented the whole thing termed “variably manned aircraft” [8].

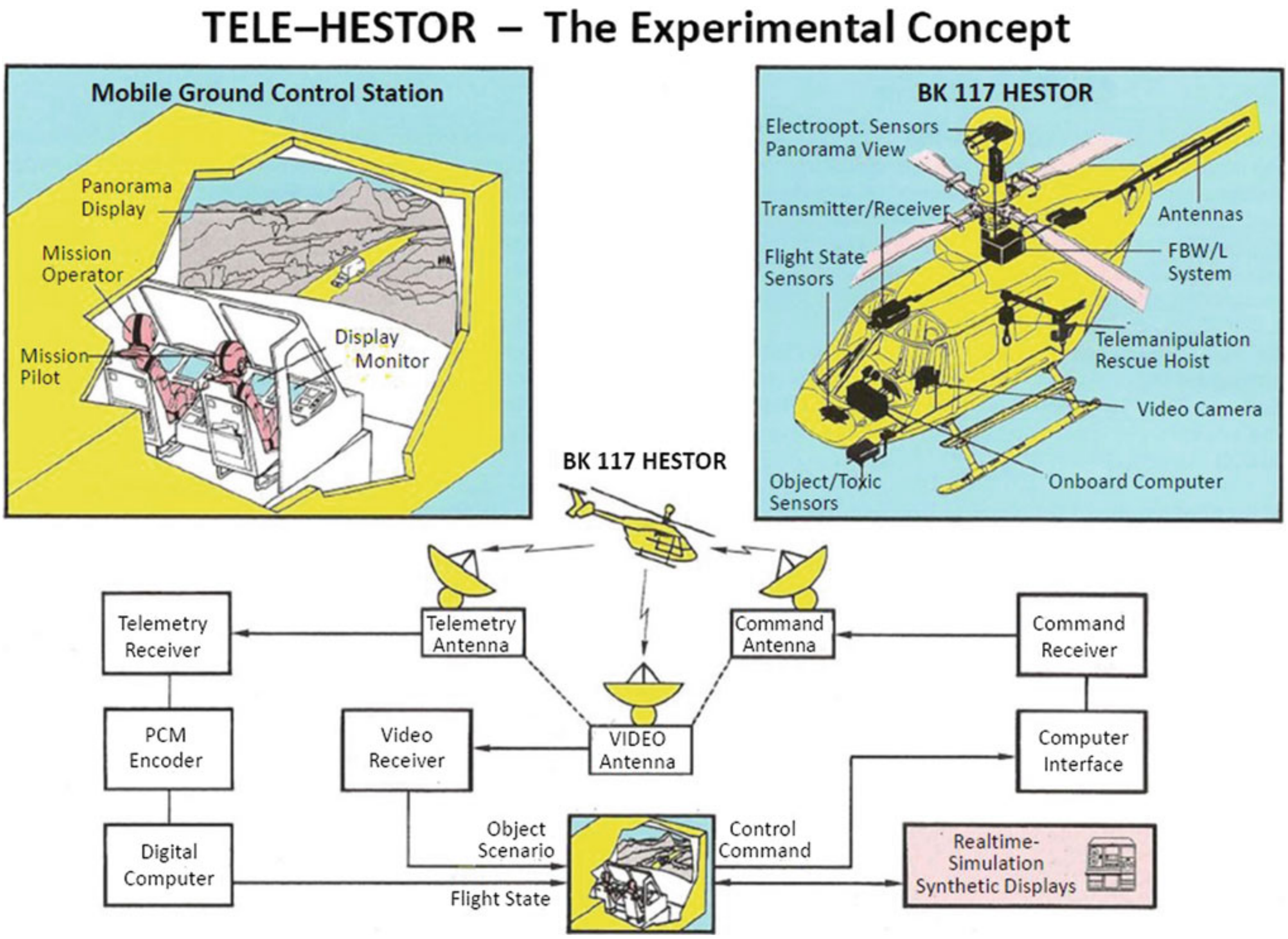

Fig. 11.11 TELE-HESTOR—the test concept

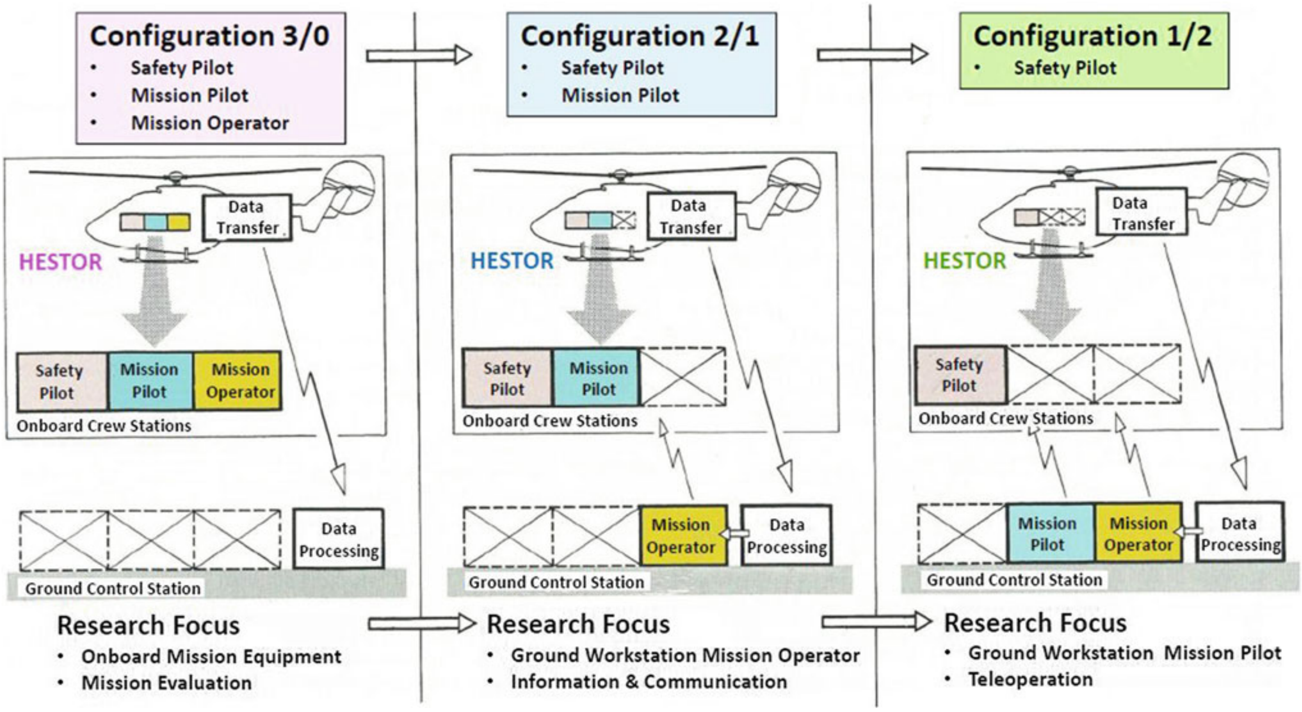

Fig. 11.12 TELE-HESTOR implementation steps

11.5 DLR/Dornier Hermes Training Aircraft (HTA) (1987–1992)

On behalf of ESA/CNES, from 1987 to 1989, the DFVLR prepared a technical concept and a complete system specification for an in-flight simulator to simulate the visual and motion information of the planned European Hermes Spaceplane (see also Sect. 9.2.2). Hermes was to be launched into space from the tip of an Ariane 5-Plus rocket and consisted of two modules: the resource module that would be separated before atmospheric reentry and the Shuttle itself that should be recovered and landed similar to the Space Shuttle. In the last version of the plan, prior to termination of the project, the Hermes was to transport three astronauts and a three-ton payload. The total mass at the takeoff would have amounted to 21 tons, which represented the maximum payload of the Ariane 5-Plus rocket.

The aim of the in-flight simulator was to provide a training aircraft for astronaut pilots, who should be able to perform a safe landing at high airspeeds after a steep descent at about 19° flight path angle. The planned flight regime of the so-called Hermes Training Aircraft (HTA) included the approach from about 12 km altitude to touchdown. Ten approaches should be possible on a training flight with a planned utilization of about 4000 sorties a year.

The glide ratios (lift over drag—L/D) of the Hermes Spaceplane and that of the HTA-host aircraft differed significantly by a factor of about 3. Hence, thrust reversal and landing gear extension on the host aircraft were indispensable besides airbrakes to simulate the Hermes flight dynamic behavior during the steep descent and landing approach. The NASA Shuttle Training Aircraft (STA, see Sect. 5.2.2.14) had to meet similar requirements. Furthermore, a stringent DLR quality criterion was developed with which the proof of the HTA simulation quality could have been demonstrated [9].

Particular attention was paid to the HTA cockpit concept to take into account different training aspects such as *Single Pilot Training* or *Crew Coordination Training*. The crew training was to be implemented by an additionally mounted cockpit (*Hermes Crew Training Flight Deck*). The HTA concept and system specifications generated by DLR served the ESA/CNES as the basis to float a tender for the development of HTA [9–19]. Proposals with detailed recommendations for the implementation were submitted by two vendors based on the Grumman Gulfstream II and the Dassault Falcon 900 (see Fig. 11.13), which were evaluated by the DLR. The functional ability of the proposed simulation concept was demonstrated in an ATTAS in-flight simulation. The achieved simulation quality is given in Fig. 11.14. It can be seen that the deviations in the roll rate between the Hermes model and the actual flown ATTAS response lie within the "permissible" mismatch boundaries of the DLR quality criterion.

Fig. 11.13 Dassault Falcon 900 chosen as HTA-host aircraft

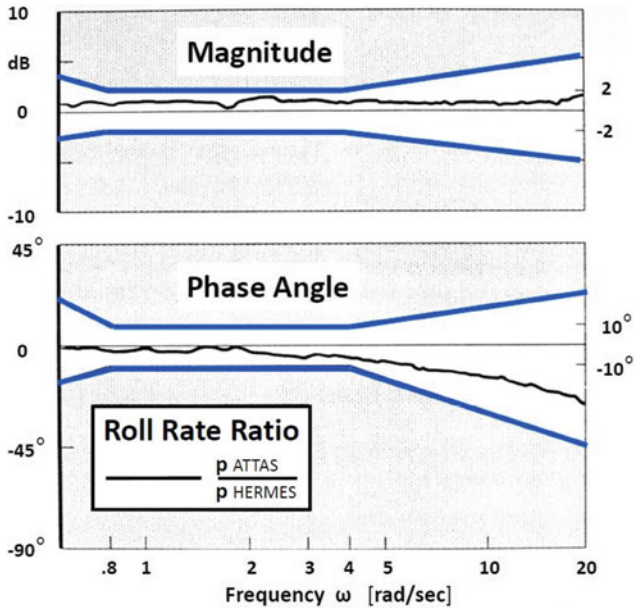

Fig. 11.14 Simulation quality of Hermes in-flight simulation with ATTAS

After the technical, financial and political scenarios had changed in Europe, the European Hermes Spaceplane project was discontinued in November 1992, giving preference to space capsules with parachute recovery.

In conclusion, from the European Hermes Spaceplane project, only a rich treasure of multinational project experience and a beautiful plastic demonstration model were left over (see Chapter title picture).

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Author Biography

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