Chapter 16
Descendants: Of Astronauts and Wings

After the decision not to continue the Hermes programme with the aim of developing an operational vehicle, ESA turned to a number of manned or possibly manned concepts and supporting technology studies. In the context of the ‘reoriented Hermes Programme’, which was renamed Manned Space Transportation Programme (MSTP) after merging with the Columbus Programme in 1995, a relatively broad spectrum of vehicles was considered, ranging from capsules of various sizes and configurations to, again, spaceplanes. The latter option was developed in two concepts involving cooperation with NASA and Russia respectively.

16.1 D0

1992–1993
Following the reorientation of the Hermes Programme at the end of the Phase C2 extension, EuroHermespace continued feasibility studies of a winged vehicle during Phase D0. Relying heavily on the vehicle shape and technologies developed for Hermes, two variants were defined, aimed at crew and cargo transport to the planned Russian Mir-2 and US-led Freedom stations.

The study did incorporate a bibliographical survey of two recent spaceplane studies, from both the US and Russia.

The American one concerned the HL-20 Personnel Launch System (PLS) lifting body concept with the capacity to carry up to eight astronauts. Its aerodynamic shape was derived from the Soviet BOR-4 test vehicle, flown as part of the Buran programme. More recently, the BOR shape surfaced once again and formed the basis of the Dream Chaser design, which is actually destined to be used for cargo transfer to the International Space Station (see below).

The Russian MAKS (Mnogotselevaya Aviatsionnaya-Kosmicheskaya Sistema, Multipurpose aerospace system) concept was based on employing an Antonov
225 aircraft as the ‘first stage’ of a launch system involving a small spaceplane with foldable wings and a disposable external fuel tank.

In the EHS’s opinion, both concepts lacked credibility and the Hermes concept was used for the definition of the new spaceplane concept.

The vehicle should be able to carry up 1500–2300 kg of cargo and return with 2500 kg from orbit, carry up to eight astronauts and have an orbital lifetime of six months.

The D0 vehicle concept A was a simplified spaceplane compared to the Hermes Stage 2. It featured a new shape (8RX2), which retained the 85 m² Hermes wing at a span of 9.3 m but had an enlarged, 3.2 m diameter, double skinned fuselage (see Fig. 16.1). Its front would be of a new shape in which the cockpit and windscreens

Fig. 16.1 Hermes D0 was a Hermes-derived vehicle studied for about a year after the programme’s reorientation (© Airbus Defence and Space SAS)
were deleted. A docking system of the Russian APAS 89-type was dorsally installed, covered by two doors. The crew of four would enter the 14.5 m long vehicle through two hatches in the forward fuselage. A propulsion system would be located in the top rear of the vehicle. The spaceplane would have a launch weight of between 17,800 and 18,300 kg, an autonomous flight capability of up to 55.5 hours, and perform a fully automatic re-entry and landing.

The concept B vehicle would be a 90% scale version of Hermes Stage 2 and include the use of a Mission Module, comparable to the former Hermes Resource Module, but without EVA hatch or docking unit. The vehicle would have a more flexible internal layout due to the added unpressurised cargo volume of the Mission Module. This module would also incorporate the propulsion system, moved from the spaceplane itself [1, 2].

Concept A was considered to have the most potential but eventually this concept was not pursued. In 1993, further studies into winged vehicles for future manned spacecraft concepts was abandoned, marking the end of the European efforts to create a spaceplane (see Fig. 16.2).

16.2 ACRV (Assured Crew Return Vehicle)

1992–1993

Even before the formal ‘reorientation’ of the Hermes programme in 1992, the Ariane Programme Board had recommended to study the ACRV upon invitation of NASA [3]. Cooperating with NASA in developing this emergency return vehicle for the ISS astronaut crew would strengthen ties with ESA’s American partners and at the same time ensure Europe would gain the experience of at least participating in the development of a manned capability. Discussions with NASA had started in
early 1992, leading ESA to fund a Phase A study between October and March 1993 [4].  

Aerospatiale led the ACRV effort and prepared a concept featuring a 6-t Apollo-type capsule, 4.4 m in diameter seating eight astronauts. A service module containing the docking unit and thrusters would be installed at the narrow front end of the capsule (configuration A), or in the alternative layout underneath the capsule, covering the heat shield (configuration B). In the latter case, only the docking unit would be located at the capsule’s top end. It would be possible for an entire crew of eight astronauts to enter the capsule within two minutes and undock within another minute [5].

ACRV was cancelled in July 1993, after which the MSTP was initiated later that year. The programme would no longer pursue a winged concept in cooperation with Russia and concentrate solely on capsule designs.

### 16.3 CTV (Crew Transport Vehicle)/CRV (Crew Rescue Vehicle)

**1993–1996**

The effort of developing a manned spacecraft was now part of an integrated plan featuring the Crew Transport Vehicle, Automated Transfer Vehicle (ATV, see Chap. 17) European Robotic Arm (ERA, see Chap. 18) and Extravehicular Activity Suit (EVA 2000, see Chap. 23).

The CTV would be a 15 to 18 t vehicle launched by Ariane 5, 5 to 7 m in length, 4.5–5.5 m in diameter and carry a crew of four inside a at least 10-m$^3$ cabin and some 400 kg of payload. The capsule would be able to return to Europe, using its 200–500 km cross-range capability, parachute and retro-rockets or airbags for a soft landing.

Two configurations of the CTV were studied in parallel over a number of years: a ‘Blunt biconic’ shape and a ‘Viking shape’ capsule design (see Fig. 16.3). Derivatives of the CTV were identified as an escape vehicle, similar to the earlier ACRV and a temporary in-orbit laboratory, which featured a Viking-shape capsule with a Soyuz Orbital Module added to its front.

### 16.4 X-38 (X-CRV)

**1996–2002**

Instead of continuing its capsule design studies, ESA decided to join NASA in developing the X-CRV after successful completion of its Phase A. The programme for a Crew Return Vehicle for the International Space Station started as a NASA in-house project at Johnson Space Center. The study was based on a lifting-body design, using the earlier American X-23 PRIME (Precision Recovery Including
Maneuvering Entry, see Fig. 16.4) and X-24 vehicles as references. A Memorandum of Understanding between NASA and ESA was signed in July of 1999 covering the cooperation on X-38, which was regarded as a key precursor of a planned barter agreement between the agencies on the Crew Return Vehicle (CRV).

The initial shape of the vehicle developed by NASA was redesigned by Dassault Aviation, limiting flow separation in transonic and subsonic regimes and ensuring compatibility with both Ariane 5 and the Space Shuttle cargo bay. NASA engineers working on the X-38 were very interested in the Dassault expertise in this field, apparently having already lost their own Shuttle experience [6].

A number of scaled test vehicles was built and tested in drop-tests from a NASA B-52, similar to the those of the X-15 rocket plane and X-24, M2F2 and HL-10 lifting bodies. The V-131, V-132 and V-131R performed a total of eight flights between March 1998 and December 2001, touching down using a parafoil parachute system.

The first X-38 that was planned to be tested in space would ride uphill on the Space Shuttle Columbia in early 2002. The V-201 measured 9.1 m in length, a maximum mass of 10 t and provided 11.8 m$^3$ in cabin volume (see Fig. 16.5). It would contain 15 ESA-provided elements and subsystems:
vehicle shape validation and overall aero(thermo)dynamic database
crew cabin design and layout for seven astronauts
aft fuselage design and manufacture of structure elements
rudders and associated sensors
metal nose structure
landing gear
cabin equipment pallets
hot structure leading edge segments of fixed fin and sensors
TPS blankets
GNC software
computers with re-entry GNC software
vehicle analysis and data recording system
predevelopment of CRV-ISS docking mechanism
active thermal control water pump
crew seat concept, representative crew seat and instrumented dummy

The X-38 programme was expected to provide ESA with key technologies required for future space transportation systems at affordable cost and controlled
risk. This knowledge would find applications in ESA’s Future Launcher Technology Programme and beyond.

By 2001, ESA was already considering a next logical step after X-38/CRV: a Crew Transfer Vehicle (CTV) might be an attractive complement to the Space Shuttle in ISS operations. However, on 12 August 2002 NASA unexpectedly informed ESA about having terminated the X-38 programme. The V-201 vehicle under construction at the time was about 90% complete (see Fig. 16.6). It still exits, but is in bad shape at an outside location of NASA’s Johnson Space Center [7–9].

16.5 CRV (Crew Return Vehicle)

1999–2007 (planned)
This would have been the follow-up programme to the X-38, expected to be at the station as an operational system by 2007. ESA expected to develop and manufacture four CRV vehicles [10] (see Fig. 16.7).
Fig. 16.6 The X-38 vehicle intended for orbital tests under construction at NASA’s Johnson Space Center (courtesy Ed Hengeveld)

Fig. 16.7 CRV would have been the operational version of the X-38 (ESA)
16.6 FESTIP (Future European Space Transportation Investigation Programme)

1994–1998
Although this programme was not primarily aimed at manned systems, it did study concepts that could have resulted in one.

FESTIP was established in 1994 with four primary goals:

- to determine technically feasible launcher system concepts
- to assess their commercial potential and development costs
- to identify the required technology developments
- to start technology development in areas common to most concepts

FESTIP’s top priority was to establish concepts that would preserve Europe’s competitiveness on the launcher market. That meant any new system should be cheaper in recurrent launch costs, so reusability or semi-reusability were obvious choices.

Eight concepts were studied in detail:

- winged body SSTO
- vertical wingless SSTO similar to the DC-X Delta Clipper
- winged SSTO horizontal takeoff from a sled
- lifting body shape similar to Venture Star
- vertical launch TSTO system
- TSTO airbreathing system similar to Sänger
- winged suborbital system, the ‘transatlantic Hopper’
- TSTO winged system with a semi-reusable variant

After the conclusion of FESTIP in 1999, the follow-on programme FLTP (Future Launchers Technology Programme) started that same year. Two of the most favoured FESTIP concepts were transferred to FTLP: the transatlantic Hopper and the semi-reusable winged TSTO. The Hopper concept did eventually make it into the testing phase as the scaled Phoenix vehicle (see Chap. 18).

In 2003, FLTP was succeeded by the FLPP (Future Launchers Preparatory Programme) and this programme is planned to be continued until at least 2018 [9, 11].

16.7 Kliper

Russia, 2002–2006
RKK Energia had started working on a potential Soyuz successor around the turn of the century. By 2002 a lifting body design had been selected called Kliper (Clipper). It was based on earlier Energia concepts of unmanned return capsule and incorporated technology from Soyuz and Buran.
In 2004, Kliper was a 12–14 t lifting body spacecraft, but later that year a winged version was revealed (see Fig. 16.8). A 20-m³ cabin, seating six cosmonauts, could be embedded in either a lifting body or winged outer fuselage, which was equipped with a thermal protection system, partly based on that used on Buran. On Kliper, the tiles would be larger at 30 by 30 cm. A living compartment attached to the rear of the cabin; this was basically a Soyuz Orbital Module, incorporating its standard docking unit.

A skirt-shaped structure surrounded the living compartment, housing thermal radiators, propellant tanks and associated thrusters. It was also equipped with eight solid-fuel rockets making up the launch escape system.

Upon return to Earth, The lifting body version would have a cross-range of 500 km and would perform landing under parachute with shock absorbers and retrorockets softening touchdown. The winged version would have a cross-range of 1200 km and use a conventional landing gear.

Kliper’s first intended launch vehicle would be Onega, an upgraded version of the Soyuz booster; later the Ukrainian Zenit was a candidate until political problems prevented this choice. Energia reverted to the Soyuz 3 option with Angara A3 as a possible alternative.

RKK Energia had funded Kliper development until 2005 when the Russian Space Agency launched a tender for an advanced manned transportation system. Energia, Molniya and Khrunichev. By this time, only the winged version was being pursued. However, the tender ended in 2006 without a winner: the federal space budget left no room for the project [12].
In 2004 Energia had invited ESA to join the development of Kliper [13], which was turned down at the Ministerial conference in December of 2005. ESA had requested 50 MAU to conduct a preliminary, two-year study of how the agency could be involved in building Kliper. ESA Director General Jean-Jacques Dordain stated after the meeting the matter would continue to be discussed: “We need two transportation systems in the world.” As NASA had not invited ESA to collaborate on its Crew Exploration Vehicle, the successor to the Space Shuttle, “this is the reason why we were proposing to be a partner on the Kliper project”, Dordain explained [14].

After the failed tender however, ESA and Energia did team up under the Advanced Crew Transportation System programme in 2006, which envisaged an upgraded version of the Russian Soyuz spacecraft with the Moon as its objective. The programme was renamed Crew Space Transportation System in 2007 and unraveled in 2008 without producing any joint results [15].

### 16.8 Dream Chaser

ESA might yet be ‘on board’ a small winged spacecraft in the near future. Although it will not be one developed in Europe, the spacecraft does have a lot of the ‘Hermes-look-and-feel’. Moreover, its latest version would be compatible with a launch on Ariane 5.

The spaceplane is called Dream Chaser and has been developed by the Sierra Nevada Corporation (SNC) in the US. Its shape is based on the earlier NASA HL-20 concept, which in turn was based on the BOR-4 vehicle used by the Soviets in the development of the Buran spaceplane (see Fig. 16.9).

Dream Chaser was a candidate for NASA’s Commercial Crew Programme, requiring a vehicle for transport of astronauts and materials to the International Space Station. In 2014, Dream Chaser lost out in a selection to its two competitors SpaceX’s Dragon and Boeing’s CST-100 Starliner.

SNC continued development of the Dream Chaser though, and had announced ‘cooperative understandings’ with ESA and the German DLR. ESA and industry were to work with SNC in identifying how European hardware, software and expertise might further the capabilities of Dream Chaser [16, 17]. The vehicle was also proposed for manned or unmanned European missions as DC4EU: Dream Chaser for European Utilisation.

An unmanned cargo version, employing folding wings in order to fit inside a rockets’ payload shroud, was selected for a contract under NASA’s Commercial Resupply Services 2 (CRS2) in January 2016 [18]. The Dream Chaser Cargo System will fulfill a minimum of six missions to and from the International Space Station, carrying 5500 kg of cargo (see Fig. 16.10). This version of the vehicle is equipped with a cargo module, reminiscent of the Hermes Resource Module and is compatible to fly within the fairing of multiple launchers, Ariane 5 being one of
Fig. 16.9 A full-scale Dream Chaser model was used for in-flights tests (© Sierra Nevada Corporation)

Fig. 16.10 The DreamChaser Cargo System is due to fly to the ISS delivering and returning cargo (© Sierra Nevada Corporation)
them. The most successful of European launchers might still get a chance of doing what it was sized for: carrying aloft a spaceplane, destined for a space station.

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