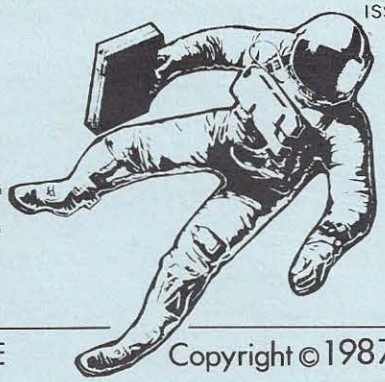
ISSN 0735-9314

THE COMMERCIAL SPACE REPORT™



A MONTHLY NEWSLETTER ON FREE ENTERPRISE IN SPACE

Volume 11, No. 7 July, 1987

The Spaceplanes of Europe
(Part One)

The European community is working to develop a manned space launch capability that will begin operations by the late 1990s and continue on into the 21st century. Three space vehicle concepts are currently under consideration by the European Space Agency (ESA), each with its own backers and each looking for a place in the future of Europe's space program.

In this issue, and in later issues, I will give an overview of the different concepts, followed by a more detailed review of each vehicle, and how it fits into the overall European space effort.

Europe currently has no manned space launch system. European nations must rely on the United States' Space Shuttle and the Soviet Union's Soyuz to provide transportation for any European astronauts. To date, both superpowers have been relatively cooperative in providing access to space for European experimenters and scientists. Still, if Europe is to proceed with its own ambitious plans for space development (such as the Columbus manned space platform), then it becomes essential that Europe have a launch system capable of carrying men and women into space--and preferably as inexpensively as possible.

Over the past few years, a number of different ideas have been proposed by several different European nations as the solution for Europe's need for low-cost space transportation. To date, three designs have set themselves apart as the most promising: The French Hermes/Ariane 5, the German Sanger, and the British HOTOL. A brief description of each vehicle follows (each will be covered later in more detail):

Hermes: a small, winged vehicle designed primarily by French aerospace companies and space agencies. The Hermes would be launched vertically on top of an advanced expendable launch vehicle, the Ariane 5. Aside from orbital maneuvering engines, Hermes would have no on-board propulsion capability, relying on its booster rocket to attain orbit. As with other winged space vehicles, Hermes would reenter to land horizontally on a runway like an airplane.

Sanger: a German design, comprised of an orbital upper stage that would be carried into the upper atmosphere on the back of a reusable, winged, supersonic booster plane with airbreathing engines. The upper-stage vehicle would then proceed into orbit powered by rockets. Two types of upper stage are proposed: a winged, reusable manned spaceplane called HORUS (Hypersonic Orbital Research and Utilization System), and a wingless, expendable, unmanned cargo vehicle called CARGUS (from "cargo").

HOTOL (HOrizontal Take-Off and Landing): A British concept, the HOTOL would both take off and land horizontally. Unlike the Hermes and Sanger vehicles, the HOTOL is a single-stage-to-orbit vehicle, requiring no booster. HOTOL would be propelled by a combination of rockets and special advanced airbreathing engines.

The table below shows some basic specifications of each system compared with each other and with the U.S. Space Shuttle, an existing reusable manned space system.

SPECIFICATIONS OF REUSABLE SPACEPLANES

	HOTOL	HERMES/ ARIANE 5	SANGER/ HORUS	SANGER/ CARGUS	U.S. SPACE SHUTTLE
PAYLOAD [1]	5000 kg (11,000 lbs.)	3,000 kg (6,600 lbs.)	7,000 kg (15,400 lbs.) [2]	10,000 kg (22,000 lbs.)	19,050 kg (42,000 lbs.) [3]
COST OF MISSION [4]	$5 Million	$60 M	$13 M [5]	$18 M [5]	$71 Million
APPROXIMATE COST/KG (COST/LB.)	$1,000/kg ($450/lb.)	$20,000/kg ($9,000/lb.)	$1,860/kg [5] ($840/lb.)	$1,800/kg [5] ($820/lb.)	$3,730/kg ($1,690/lb.)
DEVELOPMENT COST	$5.5 – 6.3 Billion	$5.7 Billion	$8 – 10 Billion		$18 Billion
YEAR OF FIRST OPERATIONAL FLIGHT	2005	1996	2005		NA

[1] Payload delivered to 500 KM (270 nautical mile) orbit at an inclination of 28.5°

[2] Also listed as either 2 crew members + 4,000 kg (8,800 lbs.) cargo or 10 crew members + 2,000 kg (4,400 lbs.) cargo.

[3] Usable payload delivered to 190 nautical mile orbit at an inclination of 28.5°. Payload does not include crew members or propellant reserves.

[4] Indicates cost to user, not cost to operator

[5] Estimated figures

The three concepts have been in competition with each other in order to gain status--and funding--as programs of the European Space Agency. Recently, the ESA gave the Hermes/Ariane 5 system such an endorsement (see below). Now the official story is that the Hermes has been accepted by all parties as the "near term" solution to the space transportation problem, leaving HOTOL and Sanger to wrestle for the position of Europe's "long-term" (post-2000) transportation system.

The facts of the matter are somewhat different: neither the Germans nor the British have given up hope of attaining the top spot, and both nations politely but persistently continue to point out the shortcomings of the Hermes launch system in comparison to their own (more on this later in the series).

Now for details of each vehicle, beginning this month with the Hermes/Ariane 5 space launch system.

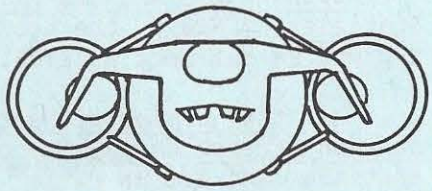
Hermes

Of the three European advanced launch vehicle projects, the Hermes and its Ariane 5 booster have made the most progress, currently enjoying the official backing of the European Space Agency (and, by implication, of the ESA's member nations) as a project approved for development.

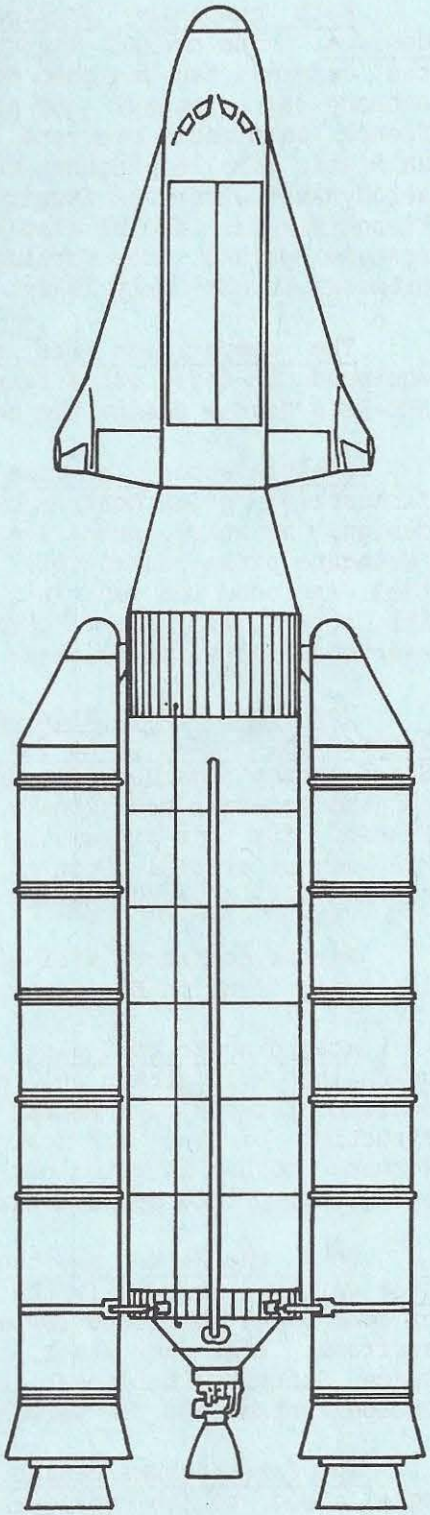
The Hermes is a winged vehicle roughly similar in configuration to the U.S. Space Shuttle, although smaller, with a length of about 16 m. (52.5 ft.) and a wingspan of about 10 m. (33 ft.) Named for the Greek god of speed and commerce, the Hermes is designed to carry a crew of three into low earth orbit (LEO) along with a payload of 3

metric tons (about 6,600 lbs.) and 1.5 metric tons (3,300 lbs.) of storable on-orbit maneuvering fuel.

The Hermes will be launched on top of the Ariane 5, an advanced expendable launch vehicle also under development by the European Space Agency (see illustration at right). The Ariane 5 provides the Hermes with the necessary velocity to attain orbit. The spaceplane has no main propulsion engines on board--only two small orbital maneuvering engines which burn storable propellants.



Like the U.S. Space Shuttle, the Ariane 5 combines liquid-fueled and solid-fueled rockets. More specifically, the Ariane 5 has a cryogenic core stage which burns liquid oxygen (LOX) and liquid hydrogen in one or more large, advanced "Vulcain" rocket engines. The additional thrust needed at launch is provided by two outboard solid-fueled rocket boosters.



Unlike the U.S. Space Shuttle, the Ariane 5 is designed to fly unmanned cargo missions without the Hermes spaceplane. On such missions, the Ariane 5 would carry an upper stage, either one burning storable propellants (called the L-5), or a more powerful one burning cryogenic LOX and hydrogen (the H-10). An Ariane 5 in its cargo mode could place 18,000 kg. (39,700 lbs.) into low earth orbit, or as much as 8,800 kg. (19,400 lbs.) into geosynchronous transfer orbit. Launch operations would take place at the Ariane launch facilities at Kourou, New Guinea.

Once in orbit, a typical Hermes mission could last anywhere from 8 days to nearly a month. The spaceplane's design missions include autonomous flights for scientific, technical and commercial purposes requiring a manned space presence, and flights to supply and service manned and unmanned orbital platforms and satellites. On completion of its mission, the Hermes would reenter, protected from atmospheric heating by reinforced carbon-carbon, tiles or shingles, and flexible insulation.

After reentry, the Hermes would make its airplane-style landing on a runway either at Kourou, or at the French Istres military test center near Marseilles. The Hermes spaceplane would require 1,500-2,000 m. (4,900-6,500 ft.) of runway.

Estimated launch costs for a Hermes mission would be about $60 million, including the cost of the Ariane 5. Development costs would be about $4 billion for the Ariane 5, and about $1.7 billion for the Hermes.

Both Hermes and the Ariane 5 were originally projects of Centre National D'Etudes Spatiales (CNES), the space agency of France. CNES began conducting studies on the subject as far back as 1976.

As the Hermes project matured into an active program, CNES held a competition between French aerospace contractors to develop the spaceplane. Two companies, Aerospatiale and Avions Marcel Daussault-Breguet Aviation (AMD-BA), submitted their separate proposals for the Hermes. The two versions of the spaceplane were similar, with minor differences such as placement of vertical stabilizers and payload bay layout.

Both companies applied their extensive aerospace experience to their proposed designs. The cockpit layout for Aerospatiale's Hermes was based on the cockpit that the company had designed for Airbus Industrie's A320 transport airliner, with five cathode-ray displays and sidestick controllers. Aerospatiale's background in other French aerospace projects (such as the Ariane launcher, the Concorde, and France's ballistic missile program) was also useful. For its Hermes concept, AMD-BA drew on the aerodynamic expertise acquired from the company's work on fighter aircraft such as the French Mirage. AMD-BA also brought to the competition knowledge on thermal protection systems gained from working with the American Grumman company on Grumman's Shuttle proposal in the early 1970s.

The competition was fierce. Reportedly, CNES considered Aerospatiale better equipped to carry out a large project such as the Hermes program, but also considered AMD-BA's Hermes design the superior of the two.

A satisfactory, no-lose solution was arrived at: Aerospatiale was selected as the "industrial prime contractor," responsible for many areas including cockpit and cabin design, avionics, power supply, and life support. AMD-BA was awarded the position of "delegate prime contractor," in charge of Hermes' aerodynamics. AMD-BA's responsibilities included the vehicle's external configuration, its thermal protection system and its structural design. CNES retained the position of overall prime contractor. With everybody happy, progress on the concept continued.

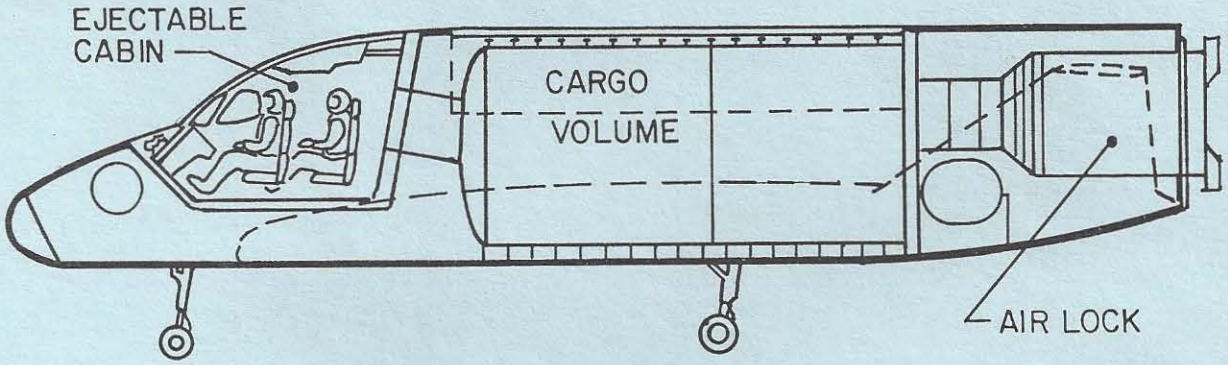
The next major milestone for Hermes was reached when the European Space Agency adopted the Hermes as an ESA project. In October of 1986, at a meeting of the European Space Agency's management council, a $35 million Hermes preparatory program was approved (the Ariane 5 had already been approved at an earlier ESA meeting in January, 1986). Funding for this preparatory program would be provided by contributions from several ESA member states. Upon the successful conclusion of this study, sometime this year, the ESA will give the Hermes project a full go-ahead for final development.

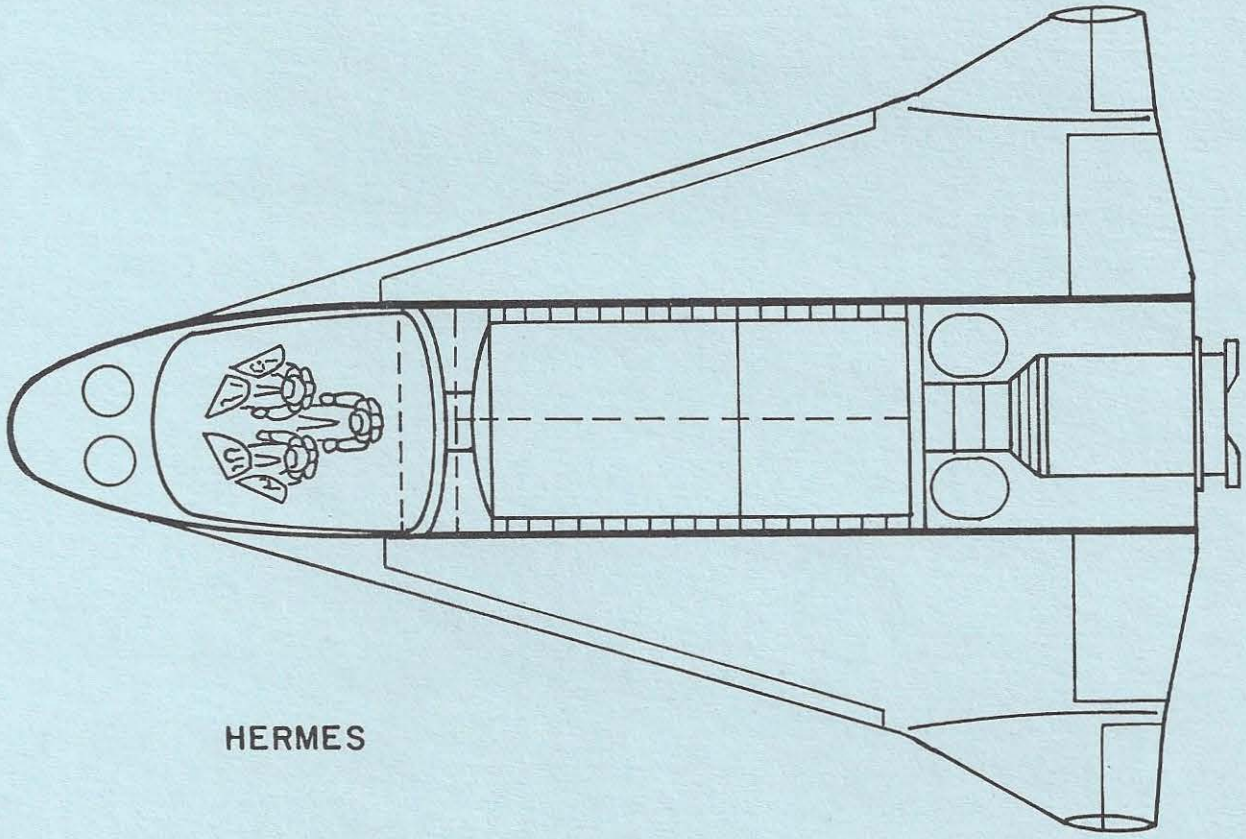
Hermes contracts will be awarded to industries throughout the ESA member nations, including firms in Britain and Germany.

According to CNES plans, if full-scale Hermes development starts in mid-1987, the spaceplane will attain full operational status by 1996. The program will include subsonic drop tests of a Hermes from a carrier airplane (a modified Airbus), and the construction of two 1/3 scale, unmanned hypersonic test vehicles called Maia (after Hermes' mother in mythology). The Maia will be launched on an Ariane 4, or possibly even carried into space aboard a U.S. Space Shuttle.

Both the Hermes and the Ariane 5 have undergone recent design changes to enhance crew safety. Originally the Hermes was designed to carry a crew of six with a payload of over 9,900 lbs. into low earth orbit. The cabin was an integral part of the Hermes airframe. Like many other, the Hermes designers were badly shocked by the loss of the Space Shuttle Challenger and its crew of seven. The Space Shuttle lacked a launch escape system, and the Hermes contractors were determined not to make the same mistake.

The first Hermes design change took place last October. Four solid-fueled rockets were added to the configuration, mounted in the skirt connecting the aft end of the





HERMES

Hermes to the nose of the Ariane 5. They would be used to propel the spaceplane away from the Ariane 5 in case of a malfunction of the launch vehicle during the initial boost phases of the flight (in a normal launch, the motors would remain behind with the Ariane 5 when the Hermes separated and continued into orbit). The number of orbital maneuvering engines on the Hermes was increased to two, providing additional thrust and control capability should the Hermes have to abort during launch and return for a runway landing.

Finally, in March of this year, a more radical design change took place, resulting in the current version of Hermes pictured above. First, the Hermes was altered to incorporate an ejectable crew cabin, capable of carrying only three crewmembers

compared to the old Hermes' complement of as many as six. The Hermes payload bay was also changed. The old version had a non-pressurized cargo bay with twin doors, similar to the cargo bay of the U.S. Shuttle. The new version has replaced the open cargo bay with an enclosed, pressurized cargo volume opening onto an air lock at the rear of the spaceplane. The design changes increased the Hermes' weight from 18 to 21 metric tons.

The twin payload bay doors are still in place, and are still opened in orbit even though they open to reveal only an inner pressurized hull. Like the Shuttle, the Hermes was designed to use the inside surface of its payload bay doors as radiators to cool the vehicle in orbit. The twin doors are still required to perform this function, even though they no longer serve as doors.

The ejectable cabin was added for safety reasons. The reason for the payload bay change is less clear. Perhaps the smaller cabin volume required the designers to find pressurized work space elsewhere in the vehicle. Whatever the reason, the change is a statement from the Hermes designers emphasizing the division of labor between the manned spaceplane and the unmanned Ariane expendable launch vehicles. In the eyes of its builders, the Hermes is not needed to launch satellites, space station components, and other payloads which require a large, open cargo bay. The Ariane boosters can handle these payloads. Instead, the Hermes will perform only those functions requiring a manned transport: ferrying crew members and small cargo items to and from a space station, or acting on its own as a manned Spacelab-type orbital experiment station.

To carry the new, heavier Hermes, the Ariane 5 has also been upgraded. As it was first designed, the Ariane 5 core stage contained 140 metric tons of LOX and hydrogen, while each outboard booster contained 190 metric tons of solid propellant. The current Ariane 5 design contains 155 metric tons of cryogenic propellants, and the fuel load of the solid boosters has been increased to 230 metric tons. This size increase not only allows the Ariane 5 to carry the larger Hermes, but it also raises the unmanned payload capacity of the Ariane 5 (with an L-5 upper stage) from 16,000 kg (35,000 lbs.) up to the aforementioned 18,000 kg (39,700 lbs.) into LEO.

Until next time,

Tom Brosz

NEXT MONTH: Sanger--An Old Idea For The Twenty-First Century

(Editor's Note: Much of the information in this and other articles on European space systems was provided by Théo Pirard and the Space Information Center (Route de la Croix-Maga, 54, B-4860, Pepinster, Belgium), an excellent source of information on the European space effort).

The Commercial Space Report (C.S.R.) is published monthly, and endeavors to report and analyze developments in the field of private initiatives in space transportation and exploitation.

Subscription rates are: U.S., Mexico, Canada: 1 year–$15.00, 2 years–$28.00, 3 years–$39.00. Foreign Air Mail: 1 year–$20.00, 2 years–$38.00, 3 years–$54.00. Back issues are available at $1.50 each from September, 1977. Xerographic copies may be substituted as stocks are depleted.

Address all correspondence to: *Commercial Space Report, P.O. Box 60547, Sunnyvale, CA 94088.* Editor: Tom A. Brosz. Tel: (415) 965-8666. Comments, ideas, or requests for information are welcomed, as are any items which may be of interest to our readers.