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THE SPACE LABORATORY--A EUROPEAN-AMERICAN COOPERATIVE EFFORT

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16. Abstract Review of the history of the European participation in the American Space Shuttle project. Some early work carried out in West Germany on the rocket-powered second state of a reusable launch vehicle system is cited, in particular wind tunnel studies of the aerodynamic and flight-mechanical behavior of various lifting body configurations in the subsonic range. The offer made by the U.S. to Euope of participating in the Space Shuttle program by developing a reusable launch vehicle is discussed, noting West Germany's good preparation in this area, as well as the ultimate decision of the U.S. to exclude Europe from participation in the design of the Orbiter and the booster stage of the shuttle.

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In the last four years a new era has been introduced for European space flight the results of which we still cannot yet forsee today. With the signing of the agreement on the participation of Europe in the Spacelab portion of the American Space Shuttle Program between ESRO, the European Space Research Organization and NASA, the National Aeronautics and Space Administration, in Washington D.C. on 24 September 1973 we obligated ourselves to develop a manned space vehicle and to jointly conduct this project with NASA dependent upon the technical development of the space shuttle to be manufactured in the United States. /40*

Thus, Europe had decided to take a step into the field of manned space flight and Europe had decided in favor of the first genuine joint space program with the United States of America. It would be years before we would be aware of the significance of this decision with respect to the obligations incurred and the potential possibilities which would be open to us.

More than fifty years ago Professor Hermann Oberth, with his scientific-technical knowledge, had predicted today's space flight technology. This historical fact shows that such guiding considerations were raised in Germany when the technical and scientific means for their realization were still unavailable. In addition, totally unpredictable political developments stood between technical forecasting and the ability to realize such goals as space flight.

*Numbers in the margin indicate pagination in the foreign text.

In order to understand the developments of the last four years it must be remembered that in this instance again a technical prediction was made in Germany with respect to the space transporter which had been researched and promoted by German firm design teams since 1962. Although we had begun in the early 1960s in the field of development with the third stage for the carrier rocket EUROPA-II and the first German research satellite AZUR in the production of space flight hardware, the reusable space transporter system was already being examined in studies and presented as the system of the future. It was quite clear that the technical means, industrial capacity, and financial capabilities of our countries would not be sufficient to engage in such a project. It is interesting to note, however, that the United States did not begin their intensive research which culminated in the Space Shuttle until seven years after the first German studies on the subject.

For more than ten years the space transporter project, like /41 the current Space Shuttle Program, was two-staged with the second stage consisting of a glider which would return into the atmosphere with the aid of aerodynamic lift as the current Orbiter. In any case, most of the design concepts were based on a air-breathing first-stage propulsion system.

The current Orbiter is more like an airplane than the then proposed lifting body configuration.

Since earlier proposals initially found no response, and since such projects could not be continued in Germany alone and since no partner for the realization of such projects could be found internationally, activity was quickly reduced to the acceptable financial level commensurate with research into the technological and flight-mechanical aspects. Among other areas of consideration, research was conducted on the aerodynamic analysis of reentry bodies which dealt with various lifting body configurations both theoretically and through wind tunnel testing.

However, particular emphasis was put on research into materials, in particular heat shielding systems, since structural heat shielding represented the most difficult problem with respect to reentry bodies. For example, such heat shielding materials were tested in the city of Trauen by ERNO GmbH in the exhaust gas jet of a rocket engine.

As early as the mid 1960s we further modified our proposal by deciding that if it was not financially possible to build a booster stage for a recoverable space vehicle in Europe, to then instead concentrate on the smaller second stage and to begin with a model testing program for the second stage. Such a testing program was to be limited to various forms of liging bodies and was limited to testing the aerodynamic and flight-mechanical characteristics of the lifting bodies in the subsonic range. In the shadow of the European large-scale projects such as the EUROPA rocket and the ESRO satellites, as well as the German national satellite program reentry technology was kept in the background, although important experience was gained and well conceived program concepts developed. This period also saw the beginning of the excellent coordination of all these activities and the avoidance of duplication which culminated two years ago in the so-called ART program in which all participating firms and institutes conducted totally coordinated research in the field of reentry technology.

The first model vehicles were developed and launched from aircraft in operations over the North Sea, near the island of Sardinia, and near the island of Crete. In addition, a pallet was initially used which was towed out of the freight compartment of a Transall aircraft.

Later we mounted the space vehicle on a pylon beneath the /42 wings of the Transall aircraft and thus achieved undisturbed release of the vehicle.

In the last versions these vehicles were controllable, indeed remote-controllable over a distance of approximately fifty kilometers.

These developments were interrupted with the surprise offer of President Nixon in October 1969 to Europe to jointly conduct the so-called Post-Apollo Program the heart of which was to be the Space Shuttle, a reusable carrier system. This proposal of course found a particularly positive response in circles in the Federal Republic of Germany which had dealt all of these many years with the idea of reentry technology and who thus were well prepared for the new problems to be faced.

In the Federal Republic of Germany and in other interested European countries a spontaneous decision was made to participate in the development of the second stage of what at that time was a shuttle still recoverable with both stages. Firms formed joint teams and preparatory technology and study programs were agreed to between NASA and ELDO, the European Space Vehicle Launcher Development Organization, and ESRO, the European Space Research Organization. ERNO GmbH introduced the Orbiter model produced by its partner firm McDonnel-Douglas into its reentry vehicle program, built wind tunnel models, and channeled the test results to McDonnel-Douglas for inclusion in their studies. The Orbiter configuration was also introduced into the glider program.

The idea of participating in the Orbiter program, of building the wings or the tail assembly in Europe, of integrating a five-piece flight unit in Europe, of manufacturing the heat shield, of using Kourou at the equator as a takeoff and landing base, of developing the position control engines, etc., etc., all of these ideas, which were very seriously considered and even subjected to preliminary investigation with the financial assistance of the European Space Vehicle Launcher Development Organization and national agencies, all of these ideas had to be abandoned. The bitter final result is the fact that Europe will not be participating in the Orbiter program and the booster stage program of the Space Shuttle Program. The reasons for this are clearly due primarily to the enormously slow and extremely complicated technical-political decision-making process in Europe which appeared too risky for our American partners in order to become involved in a totally dependent relationship with us in the production of the Space Shuttle, the heart of the coming period of space operations. From a purely technical point of view a particularly complex interface would have resulted which would have represented a unpredictable risk for the development of such a new space vehicle, particularly with respect to financing with respect to the overall schedule.

However, it should not be forgotten that from October 1969 to February 1972 we had ourselves continuously dealt with constantly varying shuttle configurations with the result that NASA was never able to present us with a fixed point of reference for our contributing proposals during the first three years of preparation. We have all experienced how finally designers in Princeton were able to come up with the final design concept, developed on the basis of economical and operational considerations, on which the current booster drive system and Orbiter are based. It is quite understandable that this process underway in the United States, which was so decisive in determining the future of NASA and the future of space flight, could not yet be burdened by the factor of a still disunited European community as a partner.

Europe, consequently, set to work on developing an auxiliary system which would be required in the new age of space flight. A RAM (Research and Application Module),which was to be the prestage and part of a manned space station,was tested by ESRO, the European Space Research Organization.

ELDO, the European Space Vehicle Launcher Organization, touted the Space Tug as a European contribution to the space program with temporary success.

The Space Tug, as a independent system with its own propulsion system and fully independent of the Space Shuttle, would conduct all missions which were not located in the orbital trajectory and orbital altitude, i.e., in particular the locating and recovery of the commercial, and, in termos of application, so important, twenty-four hour trajectory at 36,000 kilometers altitude. The two extensive studies made by European teams clearly showed the technological significance of the Space Tug and its role in the design of missions to be conducted in future decades. However, the results of these studies led our American partners, unfortunately, to abruptly exclude the Space Tug as a potential European contribution to the post-Apollo space program.

This was above all due to the fact that the factor of military application, which is important for the United States, was clearly recognized by our studies which, in turn, meant the exclusion of foreign involvement in the development of such a system. This second disappointment dealt a severe blow to enthusiasm in Europe for cooperation with the United States in June 1972. France and England in particular lost interest since fruitful cooperation with the United States in the areas of propulsion, reentry and electronics, i.e., essential areas of future technologies, was now being eliminated.

Now in terms of the overall system only the Research and Application Module was left for Europe to work on, i.e., the space station which was subsequently quickly reverse engineered into a laboratory which would fly with the Orbiter into orbit, remain with the Orbiter, and return again to earth with the Orbiter. This, thus, /43
would be the system which would fill the large 18 meter long and 4.50 meter diameter cargo hold of the Orbiter when Space Tugs, satellites, or other payloads were not being carried.

This space laboratory is manned, i.e., it has room for experiments and experimeters, as well as for operational equipment and their operators. It has a pressurized cabin with a normal atmosphere and a section open to outer space itself.

The purpose of the space laboratory is currently still not clearly defined, but is to be varied, including earth reconnaissance, astronomy, technology research, manufacturing, calibration and suitability testing, and medical research. For such purposes a wide range of requirements will be levied with respect to payload weight, volumetric area available in the pressurized cabin, volumetric area in the section open to outer space, electrical output, cooling output, and the need for a human crew. For these reasons, we suggest a modular laboratory.

Aside from the fact that this laboratory is to be used to transport American payloads and serve other customers in addition to European goals, there are also technical problems caused by the direct dependency, from a technical point of view, of the laboratory upon the Space Shuttle.

During takeoff and landing at least four experimenters will be in the laboratory in the Space Shuttle. There the direct life support systems for sleep, nutrition, and hygiene are located. Work within or upon the laboratory can be controlled from a mission console located in the Space Shuttle.

Since the laboratory is not be to be separated from the Space Shuttle, it is planned that in addition to housing the crew, a number of technical services be provided via the laboratory, instead of the Shuttle, including computer capacity, electrical power, cooling power, and air conditioning. This means that NASA and Europe must work closely together during the development work to start next year.

Without going into further detail on the political decision on the future, financially tightly interdependent European space program, which has been sufficiently discussed publicly and elsewhere, an additional limitation greatly affecting the space laboratory must also be pointed out. This refers to the tight financial framework of 175 million Arithmetic Units for the spacecraft itself and the 308 million Arithmetic Units for the overall program within the limits of which work must be conducted, it is thus clear that the space laboratory has not been designed from a technical point of view, but rather within a financial framework (on a "design-to-cost" basis). In the case of known equipment such as satellites or carrier rockets, such limitations in Europe would pose no risk. However, in the case of a manned system, which has never been made, which is involved in the closest technical interface with the Space Shuttle, whose schedule must also be met, our governments, with their decision to participate, have given themselves an additionally difficult task.

Looking back on the last four years it can now be seen that Europe, in its partnership with the leading country in space flight technology--the United States, has, after what was perhaps a series of starts which were too ambitious, now found an appropriate task with the development of the Spacelab.

It is not that the space laboratory was "all" that was left for Europe, but rather that with the successful solution of this problem greater projects will most certainly be realized jointly with the United States in the next decades which were predicted by Professor Oberth long ago.

We have a great technological learning process to undergo within the next five years, for the space laboratory prototype /44
is to be delivered to the United States by 1978. In the process we will again have to deal with the difficult handicap of our

of our still insufficient European cooperation and with the European problem of our, in terms of capacity, unorganized air and space industry.

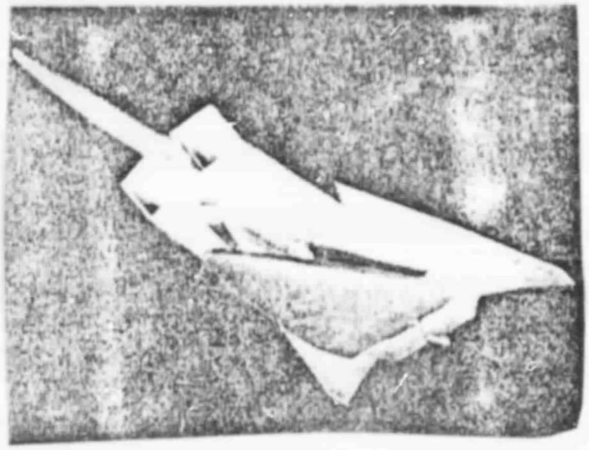
The Federal Republic of Germany, who has particularly supported this project, and which is by far the greatest supporter now with 52% financial participation, must now continue its role in a consistent manner. Aside from the fact that leadership of the project and the integration of the project will occur in our country, it will now also be very important that astronaut training be dealt with. In accordance with signed agreements a European astronaut is to make his or her first flight in 1979. It is obvious that this astronaut will come from the country which providing 52% of the financing.

In the field of utilization of this laboratory we should be more greatly involved than any other European partners--of which the next largest participant is Italy with 20% financial support, and France with only 10% financial support--and begin immediatly with the planning of missions and prepare the necessary equipment and systems.

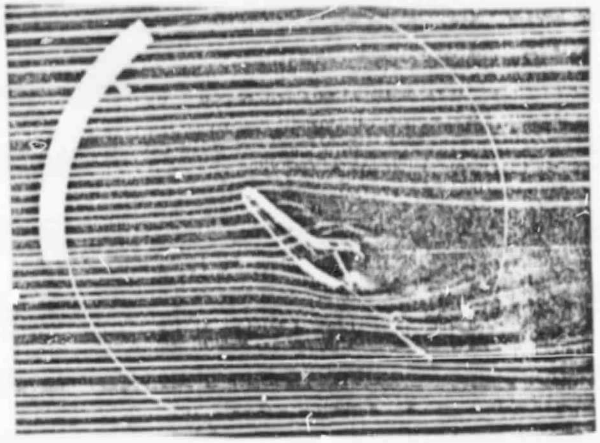
It is our duty as technical experts to complement the political steps our governments have taken and to make the most of them.

Thus, our participation in the development of the space laboratory, in the training of its crews, and in the designing of payloads, will provide us with a wealth of highly interesting technical responsibilities which will prove particularly attractive for the coming generation of technical experts. The long-term prospects into the next decade and the stabilizing partnership with the United States are additional points which make this program worthwhile which has provided us with the opportunity to directly participate in the most advanced space flight program of all.

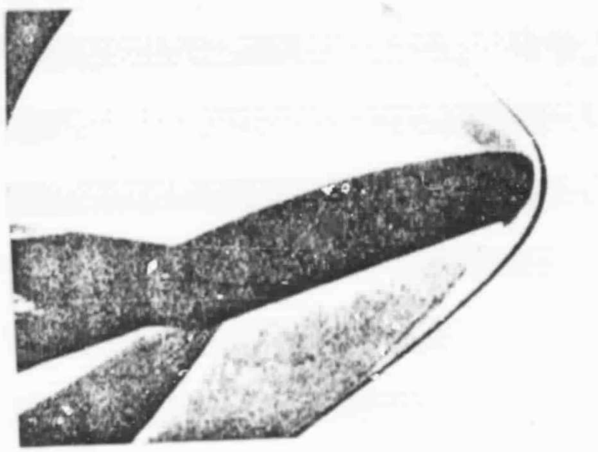
Two-stage design of a reusable carrier system developed by ERNO Raumfahrttechnik GmbH.



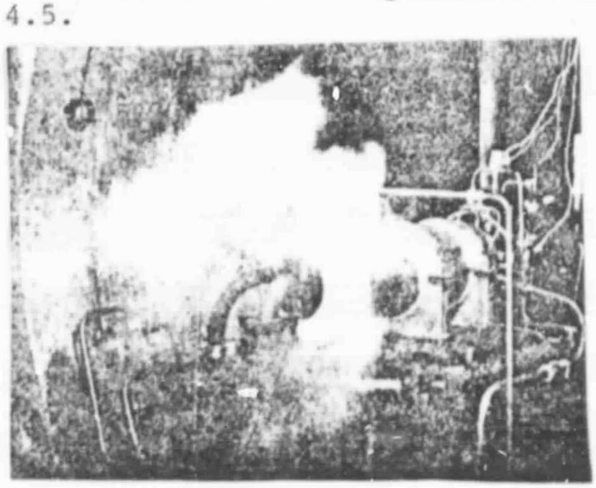
Design of a two-stage reusable carrier system with a air-breathing engine in the first stage and a rocket engine in the second stage.



Model of BUMERANG in Smoke Wind Tunnel.



Model of a LB 21 "Lifting Body" developed by ERNO Raumfahrttechnik GmbH in a supersonic wind tunnel at Mach 4.5.



Heat testing of the nose section of a test reentry aircraft.

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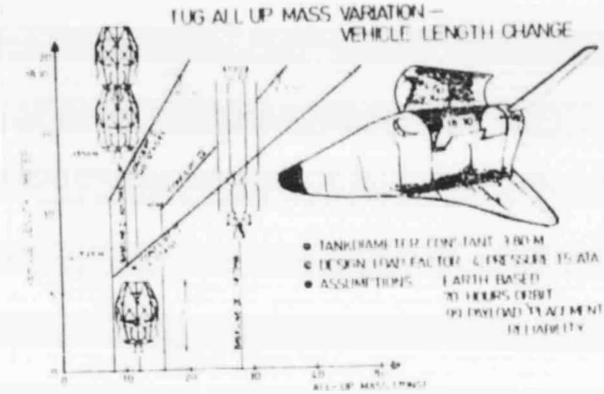
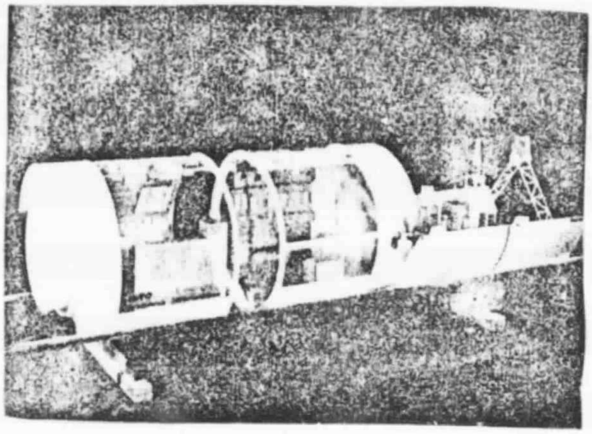
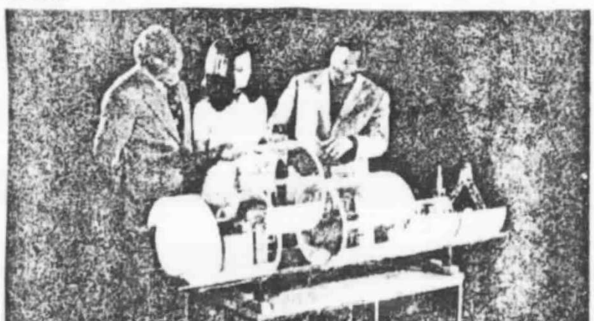


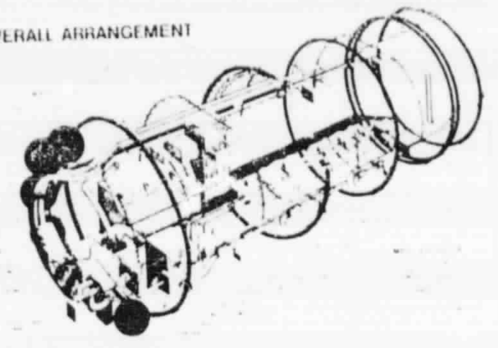
Here are some of the performance data for the "Space Tug" space taxi.



Model of the Space Laboratory designed by ERNO Raumfahrttechnik GmbH.



Model of a ERNO-designed space laboratory. Demonstration of the space laboratory's modular design.



This illustration shows the location of the most important subsystems within the space laboratory.