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THE SPACELAB PROJECT--A TRANSATLANTIC CHALLENGE FOR EUROPE

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16. Abstract

In 1972 an agreement was signed concerning the participation of the European countries in the US space program. The contribution of Europe is related to the development of SPACELAB which is to be placed in orbit with the aid of the Space Shuttle. The Federal Republic of Germany is to contribute 53% and Italy 18% of the expenses. The industrial team conducting the development work for the SPACELAB consists of experts from firms of the ten nations participating financially in the program. Attention is given to organizational problems, details on the development program, aspects of mission preparation, and future developments.

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THE SPACELAB PROJECT--A TRANSATLANTIC CHALLENGE FOR EUROPE

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The "Spacelab Program" is the point of emphasis of the pro- /57* ceedings of the XXVth Anniversary Congress of the Hermann-Oberth Society On Astronautics to be held from 9 to 12 September 1976 in Bremen in the Federal Republic of Germany. Congress participants will tour Building 16 and the "Spacelab" Assembly Hangar on the grounds of the firm ERNO Raumfahrttechnik at the Bremen Airport on 9 September 1976 from 11 am to 5 pm. The presentation of papers during the next two days of the Congress will be introduced with a presentation by Dr. H. Strub, the head of Subdirectorate 51 for "Space Research and Space Technology" at the Federal Ministry for Research and Technology. Papers presented by representatives of the European Space Agency, ESA, and NASA, and by Professor Dr. Jordan (Chairman of the Board of German Aviation and Aerospace Research and Testing Administration), and by leading members of ERNO Raumfahrttechnik GmbH will provide Congress participants with a wide range picture of the overall program.

The following article by Dieter R. Ottomeyer, head of the Technology Staff Directorate of ERNO Raumfahrttechnik GmbH, is a part of a paper he presented at the celebration of the 82nd birthday of Professor Dr.-Ing., E.h. Dr.-Ing. h.c. Hermann Oberth on 25 July 1976. (This celebration was sponsored by the Hermann Oberth Gesellschaft e.v. in conjunction with the Internationalen Foerderkreis Hermann Oberth e.v. and the Hermann Oberth Museum e.V.). This article deals in particular with the commercial situation for the West German and European aerospace industry which can expect subsequent production and further development contracts if the program is successful.

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*Numbers in margin indicate pagination in foreign text.

Introduction

Professor Oberth, Dr. Goddard, and Professor Ziolkovsky laid the basis for and developed the principles of a science and technology which we today must move into a phase of truly economical utility. A review of the current large-scale aviation and aerospace development projects underway in Europe leads inevitably to the "Spacelab" project. This project has three important characteristics which are almost a conditio sine qua non for the future of aviation and aerospace applications:

First, the Spacelab project is a large-scale European cooperative program supported and financed by ten countries. Second, the Spacelab project embodies transatlantic cooperation which combine the attempts of the United States and Europe to achieve a common goal. Third, the Spacelab project represents a aviation and aerospace project which is specifically designed for commercial and economic application. These three characteristics of the Spacelab project are the reasons why we--and by we I mean not only VFW-Fokker and ERNO, but also the Federal Republic of Germany--are dealing with the problem, why we are giving the project our full attention, and why we are exerting all of our efforts towards the support and successful conclusion of the program.

Despite the great historical contributions of Europeans to rocket development and aerospace technology, modern aerospace technology and industry in Europe is relatively young. The fifteen year existence of this modern aerospace technology and industry in Europe is sufficient, however, to clearly show specific stages of development. In the initial phases the primary goal of the European aerospace agencies ELDO, European Space Vehicle Launcher Development Organization, and ESRO, European Space Research Organization, was to develop a independent carrier rocket capacity and to conduct their own aerospace research activities. These attempts were involved with rather extensive national programs. Both activities

lead in the late '60s to a turning point from which, after nearly two years of uncertainty, the new European aerospace program evolved.

The year 1972 saw the start of the second phase of European aerospace activities. The national efforts in those countries which could afford such flanking programs in the past have now sunk to almost zero. The two former large-scale aerospace organizations ELDO and ESRO fused into the ESA, the European Space Agency, which not only represented a uniting of these two former organizations, but which, overall, represented the assumption of far greater responsibility. The new duties of the ESA now includes the advancement of technological progress, technology, and competitive capability within the aerospace field, all of which had previously been the responsibility of the national aerospace programs. ESA's responsibility also included providing European aerospace activities with a very intensive orientation with respect to application and in aiding in the shift towards work on the economical use of such aerospace activities. Although now all European aerospace activities are combined in a single organizational network, specific national interests with respect to project selection and the contribution of individual countries to the projects have been maintained and attended to. While the United Kingdom has focused her primary efforts upon the field of utility satellites and France has strongly supported the development of a European carrier rocket with the goal of achieving the same degree of independence as that of the United States, Italy and the Federal Republic of Germany have concentrated on transatlantic cooperation with the United States within the subsequent activities of the Apollo program. The new European Space Agency Convention allows multinational cooperation which takes into consideration the special interests of individual countries via socalled "special projects" in which the financial participation and the financial return is not regulated by the gross national product, as during the first phase of European aerospace activities, but rather on a voluntary basis.

The discussion in Europe on the new orientation of the European aerospace program was provided a considerable impulse in 1969 by the offer of the President of the United States to Europe to participate in the so-called Apollo successor program. Europe worked for two years in order to research the technical possibilities, to decide on the type of financial participation which would be involved, and in order to come to a final agreement with the United States. In 1972 a Memorandum of Understanding was signed in which Europe agreed to participate in the Apollo successor program and specifically to cooperate in the development of a multipurpose laboratory called the Spacelab which would be transported by the Space Shuttle developed by the United States. Italy with 18% and the Federal Republic of Germany with 53% financial participation were responsible for approximately three-fourths of the financial burden and of the contribution in technical work with respect to these European obligations. This project seemed so attractive and important for these two countries that it was agreed that the development of the Spacelab would be the special project for both countries to which both countries would make their largest financial contribution within the European Space Agency.

This decision of the two countries, Italy and the Federal Republic of Germany, put Europe, for the first time, in the position of entering the field of manned aerospace research. However, this decision also confronted Europe with the largest aviation and aerospace project conducted on a cooperative basis ever attempted at that time within the framework of equal partnership between Europeans and Americans. It was this decision which enabled us to participate in a aerospace project with the advantages and rights of a partner in a project designed for economical application, and for specifically commercial purposes. /58

The Spacelab project in general represents one of the three supporting pillers of the second phase of the European aerospace

program. With the OTS/MAROTS (Orbital Test Satellite/Maritime Orbital Test Satellite) projects as well as the ARIANE project goals could be defined within Europe which would also meet the special requirements of the United States and France so that the European Space Agency would be able to have a well balanced European aerospace program in which ten nations would participate and which would meet the special interests of all of these countries in a manner which would also be insured by stable political support.

Duties

Our Spacelab contribution is interrelated with the development of a space shuttle to which the space laboratory must adapt and with which a space laboratory must be compatible. This fact makes the Spacelab project very difficult and complex and requires highly effective management. The Memorandum of Understanding states that no development work on the Spacelab is to be conducted in the United States and thus NASA will have to depend on the Spacelab developed in Europe for the many Spacelab missions to be conducted just as Europe will have to be able to depend upon the Shuttle launchings conducted by NASA for their Spacelab missions.

In addition to the programmatic mutal dependency of Space Shuttle and Spacelab, the unique nature of the Spacelab program also lies in the technical interface with the Orbiter program which has far different dimensions than those type of programs with which we Europeans have been familiar with to date in terms of our satellites which have been developed in Europe and then launched as a payload with NASA carrier rockets. The nonreleased Spacelab is supported during its mission by the Orbiter power supply units. During ascent and descent the Spacelab crew is located in the Orbiter.

In addition to the programmatic and technical mutual dependencies the decision-making process for both partners was subjected to technical limitations for financial reasons. In 1972 NASA had to make a decision on a compromise for the space shuttle, i.e., between the development of a partially reusable launching system and a much more expensive two-staged, fully reusable system. A year later the Spacelab development program in Europe was subjected to a so-called "Design-to-Cost" approach. This meant that a Spacelab was to be developed for a given contribution of development funding which would not necessarily be the most desirable or the absolute best of Spacelabs. This also meant, among other things, that the Spaclab would consist of only one laboratory in its development phase. For this reason the development program allowed no graduated introduction of improvements, modifications, and changes during the various program phases or a planned graduated introduction of improved performance parameters in more than one space laboratory.

Consequently, the Orbiter/Spacelab partnership had to be conducted in full agreement with very strict financial limitations for both parts of the program. We have learned to live with these facts during the first two years of our joint participation and we have been successful. If we are to be successful throughout the entire program to the end our respective gorvernments would be well advised to in the end continue with both parts of the program, i.e., with the development of the Space Shuttle in the United States and with the development of the Spacelab in Europe in order to improve the performance of the respective systems with the goal of meeting requirements which must be met within this decade due to financial limitations.

The Industrial Team

The industrial team conducting the development of the Spacelab consists of firms from all ten countries which are financially participating in the program. The program is being managed by two firms: VFW Fokker and ERNO Raumfahrttechnik GmbH who were selected following a bid solicitation phase. The selection of the primary contractor from the Federal Republic of Germany was due to the fact that the Federal Republic of Germany was financially participating at a level of approximately 53% in the program.

VFW-Fokker and ERNO Raumfahrttechnik GmbH, wo were given the primary contract on 5 June 1974, are the first European aviation and aerospace companies which have attempted, through the fusion of the former firm Fokker in Holland and VFW in Germany, to create a international, industrial unit in the aviation field which extends beyond European borders. Thus, the primary contractor now has the highly valuable experience of an international European cooperative effort within a fused industrial concern to draw upon. From the top management level down to all levels of the organization those working on the Spacelab program have drawn not only upon their experiences in international cooperative efforts, but also upon their experiences in everyday internal activities of their respective firms.

In the aerospace field the industrial consortium which has been given the responsibility by the European Space Agency of developing the Spacelab has in the past fifteen years been dealing within the framework of national programs as well as within European Space Agency programs with the development of aerospace vehicles in Europe. In conjunction with these programs Europe has contributed a number of significant projects in the researcah and use of space starting with simple satellites put into orbit and culminating in rather sophisticated satellites and probes launched recently. Such examples include the German solar probe HELIOS,

which approached the sun as close as one-third astronomical units, and the German-French telecommunications relay test satellite SYMPHONIE. Another example is the Orbital Test Satellite (OTS) of the European Space Agency which represents a future standardized communications relay payload platform, as well as the Maritime Orbital Test Satellite developed for maritime navigation. The teams which worked on these projects and the facilities built for the testing and qualification of the European aerospace progjects are available and can be used for the Spacelab program.

On the industrial side in Europe the firm which has been given the contract is VFW-Fokker. This firm has given the responsibility of implementing program management for the Spacelab project to the firm's subsidiary for aerospace technology, ERNO Raumfahrttechnik GmbH. At ERNO a separate project team has been set up for the Spacelab project which consists of the technical directorates for Development and Design, Operation and Integration, and the directorates for Product Quality Control Assurance, Project Control, Contract Management, and Configuration Control, and the special directorate for Cocontractor Management. Approximately 70% of the overall work is being performed by our partner firms the cocontractors. The composition of the team was achieved in a manner of an optimum compromise between the fulfillment of requirements with respect to the achievement of a financial return corresponding to the contribution of the respective countries, the creation of a minimum number of difficult technical and management-related interfaces, while achieving the best possible utilization of the capacities and experience existing within the firms. The core of this industrial consortium is the MESH Satellite Group which has already successfully developed the until now largest ESRO satellite the TD-1A Satellite and which in late 1973 was selected to develop the Orbital Test Satellite (OTS) and the Maritime Orbital Test Satellite (MAROTS). Some firms who were not members of the MESH consortium joined the

Spacelab team as a result of the selection procedure for the Spacelab contract. The backbone of the program, however, is the MESH consortium which have been working very close together since 1964 on various projects and who no each other very well now.

The Spacelab consortium established a Board of Directors consisting of one ·emeber from the top management of all of the firms in the consortium in order to have a platform for project management at the highest level. This Board of Directors meets every three months or just prior to the conclusion of an important program milestone in order to discuss the general problems involved in the actitivities of the consortium and in order to deal with problems which go beyond the areas of responsibility of the designated project managers. Thus on the industrial side the Spacelab program has an institution which can at all times insure the full engagment and continuous informing of top management. Until now this group has contributed essentially to the Spacelab program having run so smoothly despite the challenges facing the program.

THE INDUSTRIAL SPACELAB CONSORTIUM

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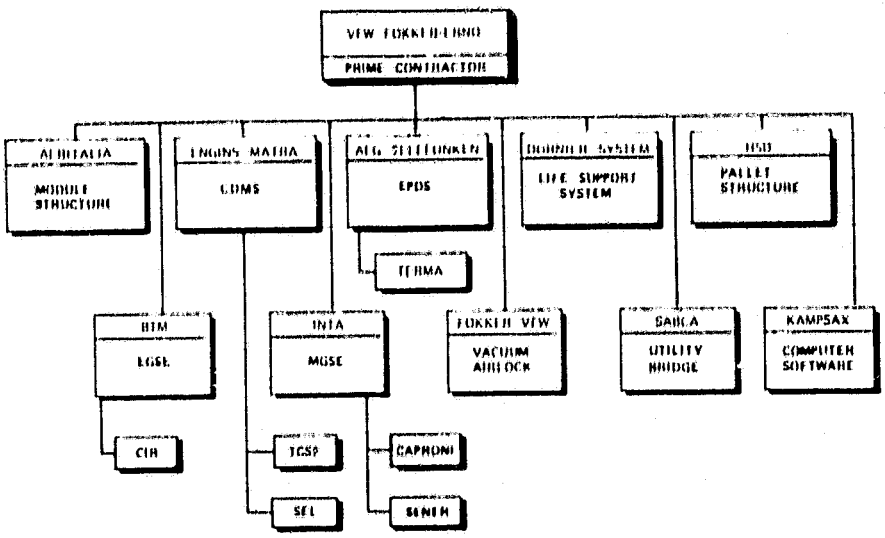

The Program Situation

The Spacelab development program is now two years old. Work has followed closely to the prescribed plan since the letting of the contract on 5 June 1974. Work on system design and subsystem design began in 1974 with subsystem production starting in 1975. These activities have now taken us to the turning point between the paper phase and the hardware phase. All required documentation has been established and the procurement as well as production of jigs and tools for all subsystems has been begun as well as the preparation of circuit boards.

In November 1974 the first significant milestone, the socalled Preliminary Requirements Review, was concluded in which Spacelab requirements at the system level were reviewed, modified, and confirmed. Ninety-two documents were provided for the review. In June 1975 requirements at the subsystem level were reviewed as part of the Subsystems Requirement Review milestone. A total of fifty-two documents were presented and discussed for this milestone. In addition to the fifty-two documents reviewed a socalled Soft Mockup which included the Spacelab was created and turned over the the contractor.

From this moment on great efforts were made to complete a main contract between the European Space Agency and VFW-Fokker/ ERNO. This contract was signed on 30 September 1975 in the main office of the European Space Agency in Paris meeting exactly the deadline for achieving this agreement. At the same time the primary contractor concluded the three extensive fixed-price contracts with the cocontractors Hawker Siddeley Dynamics, AEG, and Aeritalia. This meant that an agreement with respect to the Work Statement as regards the main contract and the three fixed-price contracts, with respect to the system and subsystem specifications, and with respect to the legal clauses and project plans had been met and that the project from now on would have a solid framework from

within which to conduct activities. In the area of cost reimbursement contracts contracts were signed with Bell Telephone Manufacturing Comapny in Antwerp, Belgium, with Fokker-VFW in Holland, and with Dornier System in the Federal Republic of Germany.

A series of Preliminary Design Reviews for all subsystems were conducted in the first half of 1976. This was the next significant milestone in the program which will be followed by the Interim Design Review in 1977, the Critical Design Review in 1978, and then the delivery of the Enineering Model No. 1 to NASA in May 1978 and the delivery of the Spacelab to NASA in May 1979.

Missions and Applications

The Memorandum of Understanding between the United States and Europe calls for the first two missions being jointly conducted after the delivery of the Spacelab by Europe to the United States. One condition is that the exploitation of these two missions be divided on an equal bais, i.e., 50% American and 50% European experimental packages would be transported into space.

A Joint Group for Utilization Requirements of NASA and the European Space Agency has been working these many months on the detailed goals of the first mission which is to be flown in the first half of 1980. It was agreed to fly a Spacelab configuration having a elongated module with a small pallet. The mission is of a scientific nature and is designed primarily to test the flight performance of all Shuttle and Spacelab subsystems and the proper operation of all interfaces. The second mission will probably be flown only in a single pallet mode with the pallet used to transport large observation instruments for astonomical and earth reconnaissance purposes into space aboard the Spacelab. Although no astronauts and laboratory exeperimentors have been selected yet, it is understood that Europeans will also be part of the team of

operators and experimentors and it is also understood that at least one member of the crew of the first flight will be a European. The corresponding selection and training of such personnel has already begun and discussions have been initiated between the European Space Agency and NASA as to how the Spacelab payload spcialists are to be selected and trained.

A requirement that participating European firms provide ideas and suggestions resulted in a considerable number of proposals for the first mission. Since only 50% of the payload could be contributed by Europe, the European Space Agency is currently selecting the experiments which will fly with the first mission and those experiments which have been postponed for later missions. General planning calls for the third mission to be the first in which primary emphasis will be given to experiments with respect to manufacturing in space.

In general it can be said that interest is growing in the United States and Europe in the use of the Spacelab. An ever increasing number of tasks and missions are being drawn up. Intensive programs are underway to make the most of the time available until the Spacelab is actually on hand in the United States as well as in Europe, and in particular in the Federal Republic of Germany. One of the preparatory programs conducted by the Federal Republic of Germany with respect to the Spacelab Payload Rocket Program using an American rocket involving a tool experiment in space during ten minutes of weightlessness resulted, among other things, in the development of a highly promising new semiconductor material.

The ceramics industry and the manufacturers of optical glass in addition to metallurgists, pharmacists, and the chemical industry, are particularly interested in taking advantage of the potential of the Spacelab with its ideal external vacuum and nearly 0 gravity.

Subsequent Production and Further Development

In the Memorandum of Understanding with Europe the United States promised to order further Spacelabs from Europe if reasonable conditions can be agreed upon. This fact represents a very attractive starting point for European industry, since it allows for the first time in the young history of aerospace programs in Europe the production of a system which has been developed in Europe. Of course, the number of Spacelabs produced will not be very large, but it will provide part of our team with /60
work until the mid-1980s. These orders will be financed by the United States and can contribute to some extent in compensating for the very extensive purchases of aviation and aerospace equipment by Europe in the United States (for example, until recently, Lufthansa, the primary airline of the Federal Republic of Germany, has purchased only Boeing aircraft). This, again, is a very important point for the governement of the Federal Republic of Germany.

It can now be seen that the increasingly complex utility requirements whch the Spacelab must meet and the advances in our knowledge of the combination of the American Shuttle system with the European Spacelab clearly shows that there is potential room for improvements for the future. Improvements not only with respect to the Spacelab, but also with respect to the Shuttle so that both systems together can provide better performance for a potential user. This means that a second generation of Spacelabs must be defined and development work on them begun in all too near future.

Consideration is being given currently, primarily in the United States, to constructing numerous space stations within the next decade. These space stations will be transported into space with the aid of the Shuttle and is quite possible that the subsystems developed in Europe for the Spacelab might be used in order to build a space station from modular elements. For this reason the possible participation of Europe in the construction of a space station utilizing

Spacelab elements is, in addition to the subsequent production program, another particularly attractive starting point for the future of European Aviation and Aerospace technology and industry.

Conclusions

The development of the first manned space vehicle in Europe represents an ambitious risk in the still young history of aerospace technology. If the Spacelab development program is successful a decisive step forward in the advancement of modern aviation and aerospace know-how will have been taken. From a technological point of view this step is the logical continuation of work in the field of automated aerospace systems which have been successfully developed in Europe for the past fifteen years. Thus, the decision to develop the Spacelab as a manned system can be considered a normal extension of the work conducted to date in the aerospace field. Such work represents a spacial rechanneling of meghods and procedures which have already been put into practice across a broad spectrum of fields. The decision demonstrates the determination of a large number of European countries to continue work in the aerospace field, to support technological advancement, and to make scientific and economical use of the potential posed by aerospace technology.

The true progress in the Spacelab project lies in the fact that the Spacelab system is part of a joint American-European venture. If the step from automated to manned systems is considered technologically a logical continuation of aerospace efforts, then the creation of a genuine partnership between the United States and Europe is something new . In this venture the contributions of both partners create a mutual dependency, since there is no redundancy in the contributions of each respective partner. There is no Spacelab development program going on in the United States and no Shuttle development program going on in Europe.

We are all aware that there is still much to do. First of all European industry must meet its obligations successfully so that the trust which our partner the United States has in us is justified. Secondly, we must be able to prove to our taxpayers in Europe that the European money spent for aviation and aerospace purposes is being well spent. We need the continued support for our project from our respective governments. European governments in particular should soon initiate discussions with the United States with respect to an expansion of the Memorandum of Understanding which currently deals only with the first two Spacelab flights. No at a time when the United States has not developed a Spacelab Europe should negotiate for acceptable and favorable conditions for the period the Spacelab is to be used which would for all practicle purposes cover the entire decade of the '80s. All partners, industry as well as government, should require that the Spacelab be usable for a wide variety of users, particularly for those which until now have not been able to be involved in aerospace activities. If everything goes well Europe will certainly be contributing to the next generation of manned space vehicles and again be an equal partner with the United States of America.