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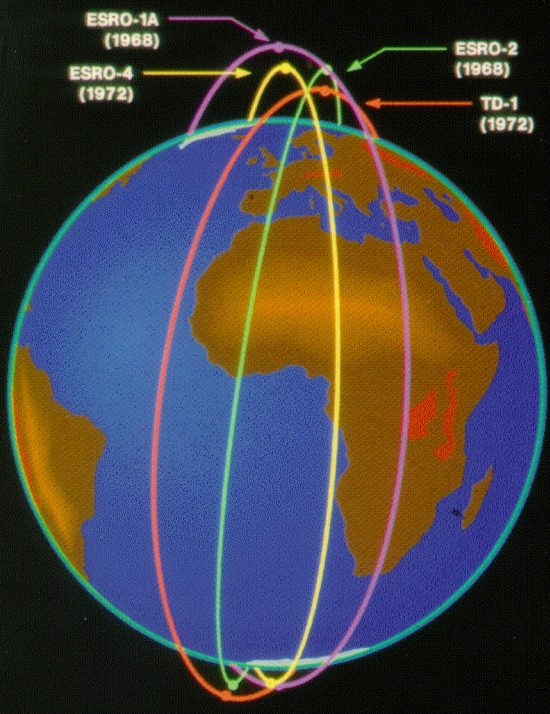
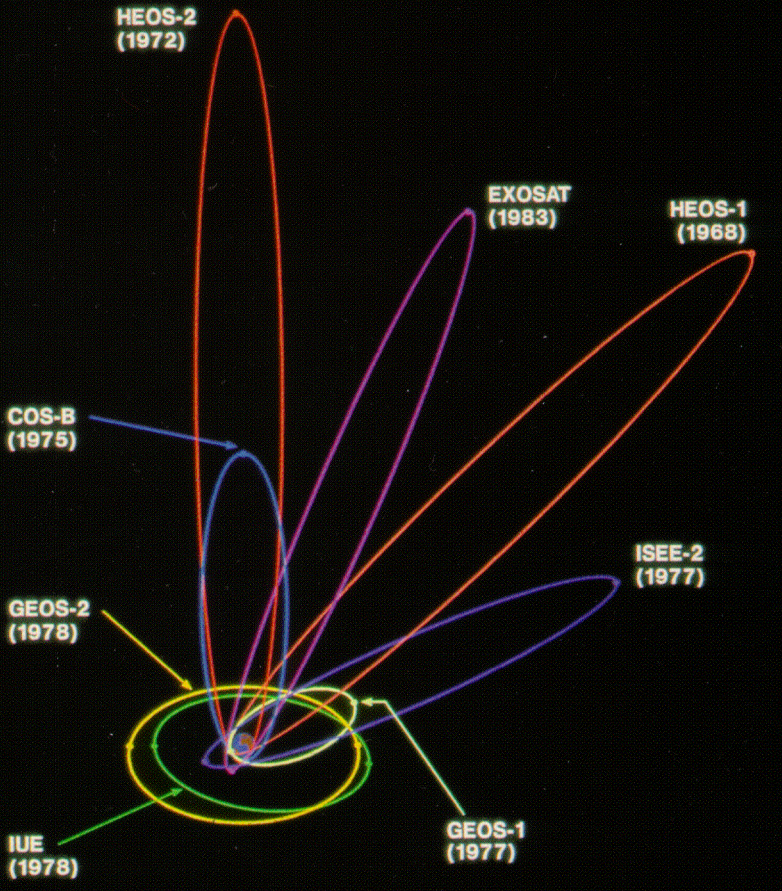
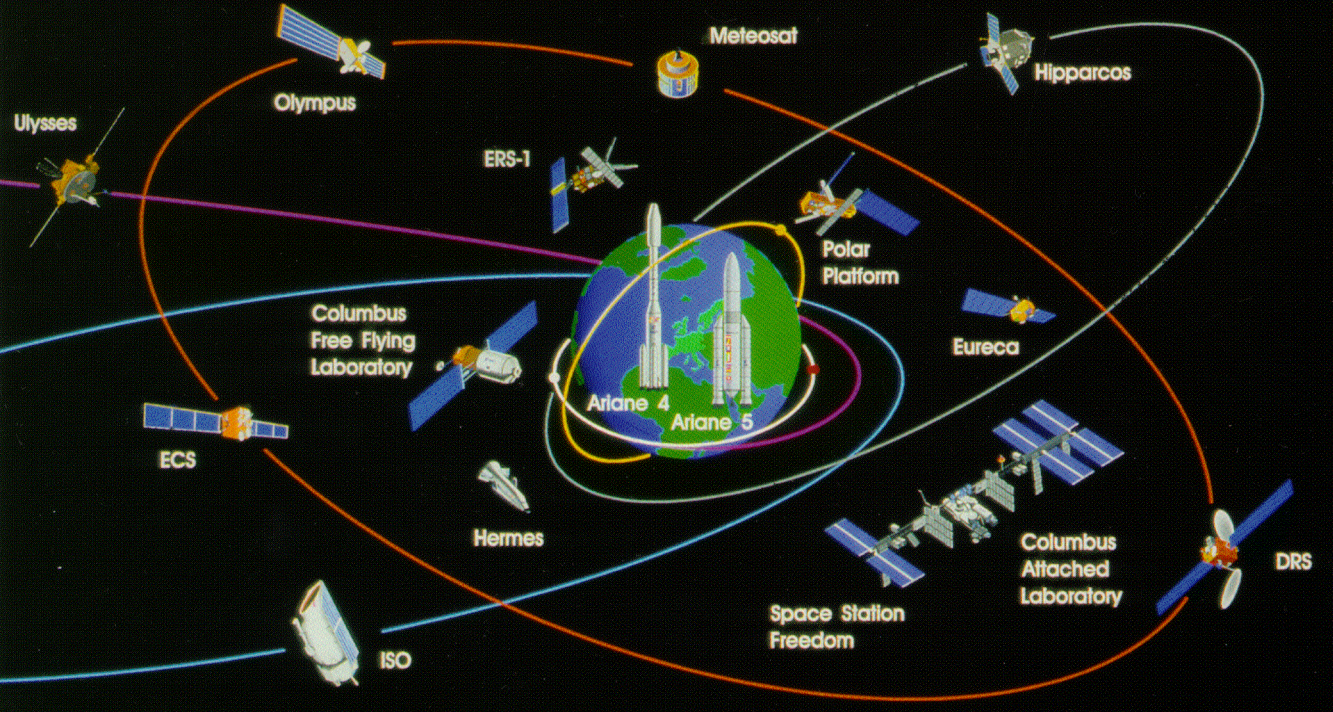




The history of ELDO
Part 1: 1961-1964

by Michelangelo De Maria



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The ESA History Study Reports are preliminary reports of studies carried out within the framework of an ESA contract. As such they will form the basis of a comprehensive study of European Space activities covering the period 1959-87. The authors would welcome comments and criticism which should be sent to them at the appropriate address below.

The opinions and comments expressed and the conclusions reached are those of the authors, and do not necessarily reflect the policy of the Agency.

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The history of ELDO. Part 1: 1961-1964

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The history of ELDO. Part 1: 1961-1964

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1. The origins of ELDO

The prehistory of ELDO is well known since it has been clarified by De Maria & Krige (1992) and, more in depth, by Krige (1993a). The military origins of *Blue Streak*[1] and *Véronique*[2] — the first and second stage of the proposed European launcher, respectively — are also known.

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[1] *Blue Streak* was conceived and planned in the UK during the early and mid 1950s in order to counter the USSR nuclear threat. It was an IRBM (Intermediate Range Ballistic Missile) with a maximum range of 5.332 km. It was 10 ft in diameter and about 80 feet long; its weight (with fuel) was about 90 tons. Its two RZ-2 engines, fuelled with liquid oxygen and kerosene, had a combined thrust of 300,000 pounds. In its civil improved version, as the first stage of *Europa 1*, *Blue Streak* could develop a thrust of 136.000 kg. It was built by de Havilland at Hatfield works and test site, after the model of the US missile *Atlas*, on licence of US General Dynamics/General Astronautics. Rolls-Royce made a similar agreement on rocket engines with the Rocketdyne Division of North American Aviation Inc., which was responsible for the design of the *Thor* engines. *Blue Streak*'s engines were tested at the Spadeadam site in Cumberland. Also Saunders Roe and Sperry developed some of its major components. The substantial US know-how flown in the design of *Blue Streak* accounts for the rapid progress made in its realization despite its being the first ballistic rocket ever built in Britain. Pardoe (1961); *Spaceflight*, 4:1 (January 1962), pp. 2-3; Stubbs (1963); Cleaver (1964); De Maria & Krige (1992), pp. 111-112; Krige (1993a), pp. 2-6.

[2] The French IRBM programme was initiated on 15 March 1949. The Army's *Laboratoire de Recherches Balistiques et Aérodynamiques* (LRBA), whose main contractor was located at Vernon, near Paris, developed a liquid-fuelled rocket programme (initially designed after the model of the German rocket V2) and christened it *Véronique* (from VERnon-électrONIQUE). Within the *Véronique* programme, different models were developed between 1950 and 1964. The first standard version, *Véronique AGI* (for "*Année Géophysique Internationale*"), was successfully launched 50 times between 1957 and 1964. Fuelled with turpentine, it developed a thrust of 4810 kg and could reach a maximum altitude of 200 km with a payload of 60 kg. The performances of further versions were considerably increased: *Véronique 61* performances (from the 1961 programme; 13 launches

Blue Streak was liquid fuelled and its obsolescence as a military missile for nuclear retaliation was due to the introduction of solid-fuelled missiles — *Polaris* and *Minuteman* by the US and similar strategic vectors by the USSR — with a much shorter launching time. This was the main reason for the decision taken by the British government in April 1960 to cancel *Blue Streak* as a military weapon. This bitter pill, however, was gilt by the US promise to supply Britain with *Skybolt* missiles, so that it could maintain its nuclear deterrence capability unaltered in a much less costly way. However, *Blue Streak*, though militarily obsolete, could be easily transformed into a very efficient first stage of an heavy satellite launcher. The British therefore first looked into the possibility of recycling it as an all-British satellite launcher. But several reasons stopped the British from developing a national launcher.

Firstly, there were technical reasons: as G.K.C. Pardoe, Chief Weapons Research Engineer of de Havilland explained, putting *Black Knight* on top *Blue Streak* "would result in a complete vehicle that is rather long and thin and this upper stage is by no means ideal in relation to the capabilities of the booster on which it rides"[3]. Secondly, there was the cost: *Blue Streak* had already cost some £65 million ($182 million, at 1959 rates) and, according to various estimates, the total cost of an all-British heavy satellite launcher based on *Blue Streak* as first stage, a modified version of *Black Knight* as second stage, and possibly a third stage based on an existing motor, would have been £110 million, spread over five years, i.e. some £22 million per annum.[4] The British policy on *Blue Streak* has been described by Christopher Layton as the result of "a disastrous conflict between ambitious ends and limited means".[5]

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between 1964 and 1967), was increased by 50% over *Véronique AGI* (thrust: 6320 kg; maximum height: 315/328 km with a payload of 120/200 kg). *Vesta*, (originally named *Super Véronique*; 10 launches between 1964 and 1970), developed a thrust of 17,500 kg and could reach a maximum altitude of 400 km with a payload of 500 kg. The French liquid propellant rocket family proved highly reliable, and allowed LRBA to develop liquid fuelled engines, like the *Vexin* and *Valois* engines, which were first used by the French for their national *Diamant* programme and, later, for ELDO's second stage *Coralie*. The last step led, by addition of turbo pumps, to the development of *Viking* engines, to be applied to ESA's *Ariane*. Gire & Schibler (1987). See also Petkovsek (1961).

3 *New Scientist* (26 May 1960), 1332-1335, at p. 1333.

4 *Black Knight* was a relatively small rocket: 35 feet long with about 50,000 lb thrust. In contrast with *Blue Streak*, it was not an adaptation of a military vehicle, since it was conceived from the very start as a ballistic rocket for research. It was designed by the Royal Aircraft Establishment (RAE) and built by Saunders-Roe, using a Bristol-Siddeley Gamma rocket motor. When Saunders-Roe was taken over by de Havilland, *Black Knight* came under the same management as *Blue Streak*. It was a very reliable rocket: its first seven firings, from September 1958 to April 1960, had all been successful. See: Goldring (1960), Pardoe (1961), Cleaver (1964); see also *Spaceflight*, 3:1 (January 1961), at p. 7.

5 Layton (1969), p. 53; Hochmuth (1974), p. 63.

However, the development of *Blue Streak* was quite complete, and it would have been a net loss to wipe it out completely both in terms of the money already spent and of acquired know-how. Therefore, the British Minister of Aviation P. Thorneycroft, while abandoning the project of an all-British satellite launcher, began to contact, as early as summer 1960, first France and later other European partners, to sound out their willingness to share space technology and to co-operate in a joint project to build an all-European satellite launcher.[6]

A common European goal underlying the foundation of ELDO was that of reducing the technology gap with the Superpowers. Krige has already thoroughly analysed the complex phase of negotiations which took place first between the British and the French, in order to bring France on board ELDO, and later with West Germany and Italy, in order to overcome their perplexities and objections.[7]

Political and economic reasons played a major role in the British decision of trying to recycle *Blue Streak* into an all-European satellite launcher: i.e. the prospected entry of the UK into the Common Market, and the money already spent into the project. Last but not least, Thorneycroft was also motivated by the goal, or better by the hope, of keeping an important segment of the British space industry from vanishing.

The reasons of the French for joining ELDO were more strictly political: the rationale of de Gaulle's decision to bring France aboard ELDO can be explained in terms of the following goals: political prestige and technological independence from the US through a quick acquisition of technological expertise and know-how in the strategically (and militarily) crucial sector of heavy launchers for its *force de frappe*. Moreover, Gaullist France, which had just become an atomic power (the first French atomic bomb was exploded in the Sahara in February 1960), wanted to establish closer political relations with the UK and attempt to loosen its ties with the USA. In fact, the Strasbourg Conference (which was the first official meeting leading to the formation of ELDO; see below) took place on 30 January 1961, immediately after the French President de Gaulle and British premier Macmillan had held private talks at Château de Rambouillet — talks at which, according to several sources, de Gaulle was "attracted by the idea of Europe becoming the third space power" and during which it was agreed to back the use of *Blue Streak* as the first stage of a European launcher.[8] And the Lancaster House Conference (where ELDO officially came into life in the autumn of 1961; see below) was immediately followed by

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6 Krige (1993a), pp. 6-12; De Maria & Krige (1992), pp. 113-114.

7 Krige (1993a), pp. 12-18 and 22-28.

8 *Ibid.* on p. 17.

the opening of negotiations in Brussels on the British entry in the EEC — a step which, as de Gaulle told Macmillan in private talks held in June 1962, France would not oppose. Behind that political back-drop France joined the British proposal and accepted to develop the second stage, which was christened *Coralie*.[9]

West Germany, on her part, prohibited from building its own rockets and missiles by the West European Treaty of 1954, jumped quickly on the ELDO bandwagon, seeing in it a unique opportunity for the acquisition of know-how in a major technological field denied her since the end of the Second World War. As Chancellor Adenauer said to Macmillan, he supported the idea of a European joint venture "with all his heart"; he hoped, in fact, that the establishment of a European launcher organization could "secure for European science and technology a proper place in the field of space travel and space research". Therefore, the German government approved its participation in the project provided "that German science and industry [were] given an adequate share of the work to be done". In particular, the construction of the technically challenging third stage was especially palatable to the Germans, since it implied the use of advanced space technologies at the very forefront of the state of the art.[10] Italy, and to a similar extent, Belgium and the Netherlands, which had not yet developed any relevant knowledge in space technology, joined ELDO in order not to miss the space train and to maintain their position as industrially developed nations.

Italy was initially by far the most reluctant of the major ELDO partners and its eventual joining was not an easy process. The Italian physicist Edoardo Amaldi, who had played an important role in the initial take-off of ESRO,[11] captained a "solid opposition" of the Italian scientific community against the Italian participation in ELDO and in defence of ESRO's scientific purity and also tried to organize a lobby of European scientists against ELDO.[12] The rationale of the long-lasting Italian opposition can be traced in the minutes of an official meeting between a top-level Anglo-French delegation and Italian officials held at the Rome

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9 Renther (1992); De Maria & Krige (1992), p. 119; Sebesta (1992), 336-340; Krige (1993a), pp. 12-18. The last point was confirmed by Blamont and others in interviews made by L. Sebesta in December 1991, in the context of the ESA History Project; transcripts at ESA archives, EUI, Florence.

10 Record of a meeting between Macmillan and Adenauer on 23/2/61, and letter Adenauer to Macmillan, 29/6/61, cit. in Krige (1993a), p. 23. The German third stage, later known as *Astris*, was fuelled with an UDMH-Nitrogen tetroxide engine developing a thrust of 2,250 kg. It replaced the originally preferred *Ophos* stage fuelled with hydrogen-fluorine.

11 De Maria (1993), pp. 5-28.

12 E. Amaldi to P. Auger, 28/10/61; E. Amaldi to F. de Rose, 28/10/61, Amaldi Archive, University of Rome La Sapienza, box 244, folder 1; E. Amaldi to J.B. Adams (copy to F. de Rose), 15/12/61, *ibid.*, box 210, folder 1.

headquarters of the Ministry of Foreign Affairs in September 1991. First, Amaldi criticized "the way in which this collaboration has got under way": from the mere fact that *Blue Streak* had already been developed by the British it followed that "in practice it could be built *only* by British industries"; the same was also true for the second stage designed by the French; therefore, industries in the other countries, and in Italy in particular, were "excluded from the most important and essential part of the project".[13] Secondly, Amaldi objected to the "general organizational scheme". The splitting up of so complex a project into different parts, to be realized in different countries, was going to create great difficulties in its management and was "wrong with regard to both the international collaboration and the efficiency of the organization". "Any responsible person", he prophetically commented a few months later, "sees the difficulty of matching three stages and the satellite made in four different countries and can easily foresee the disputes that will arise if these do not fit well together".[14] Finally, he judged that the projected rocket itself was not worth the money to be spent on it, because it would be technologically obsolete by the time it was ready, i.e. in five or, more likely, in seven years. In sum, he concluded, the Anglo-French project would not contribute to "the scientific and technical development of Europe. For Italy it [was] essentially a form of friendly contribution to the development of UK (and French) industry in this field".[15] However, it should be stressed that, apart from the reasons just clarified, the hostility to ELDO by the Italian scientists was also motivated by their determination to develop a national space programme, centred on the *San Marco* project, within the framework of a bilateral collaboration with NASA.[16]

Since Italy's possible refusal to join ELDO could undermine the entire project during the autumn of 1961 the British and the French started to put "considerable pressure" on the Italian authorities: the British and the French ambassadors in Rome made a joint approach to the government, and a personal message from Macmillan to the Italian Prime Minister Amintore Fanfani was delivered on 3 October. Moreover, German experts entered into contact with

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[13] Document entitled *Intervento del prof. E. Amaldi alla riunione che ha avuto luogo al Ministero degli Esteri il 21/9/61 con la Missione tecnica Anglo-Francese per il progetto Blue Streak*, pp. 1-2. Amaldi Archive, box 248, folder *Spazio-Europa, Corrispondenza con Broglio, 1958-1961*. See also *Verbale della riunione che ha avuto luogo al Ministero degli Esteri in data 21 corrente per il progetto Blue Streak*, box 210, folder *Blue Streak. Verbale della riunione tenuta a Roma il 25 settembre 1961 presso l'Istituto di Fisica dell'Università, ibid.* Amaldi's position on the European space effort has been analysed in great detail by De Maria (1993); see also Krige (1993a), pp. 24-25.

[14] See Amaldi's intervention in the meeting held on 21/9/61, note 13. See also letter Amaldi to Adams, 15/12/61, note 12.

[15] Amaldi to Adams, note 12.

[16] De Maria (1993), section 5.

their Italian counterparts, and steps were taken to arouse the interest of Italian industrial circles, so that they finally became convinced that the development of the test satellites for the projected ELDO launcher could produce a synergic effect on their national space programme. Moreover the Italians hoped, with the help of Germany, to push ELDO in the direction of studying and developing second generation launchers based on technologically more advanced high-energy propulsion systems. Therefore, Italy eventually joined ELDO.[17]

2. First official moves

Early in January 1961, a first official meeting of representatives from various European countries took place in London, at Church House, Westminster. There British officials submitted technical studies on the feasibility of the Europeanization of *Blue Streak*, and the French backed the British proposal, officially declaring their willingness to use their military rocket *Véronique* (later to be called *Coralie*) as the second stage of the future European launcher.

Three weeks later the French and the British convened a top-level intergovernmental conference attended by twelve western European countries at Strasbourg (30 January-2 February 1961). There they proposed a five-year Initial Programme (IP) costing £70 million ($196 million), aimed at building a three stage satellite launcher, capable of putting a 1000 kg satellite into low orbit.[18] Moreover, they offered the new European launcher organization, free of charge, the relevant know-how already acquired at their own expense, and proposed that the whole of the technical information produced by the Organization's work "would be freely placed at disposal of all Member Governments".[19]

Finally, the UK offered to increase her share of contribution to 33,33% instead of the 'normal' share of 25%, as calculated on the base of her GNP. This was due to the fact that some 55% of the costs of the IP would be for *Blue Streak* and thus be spent mostly in Great Britain.

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[17] Krige (1993a), pp. 26 and 29. See also the interviews made by L. Sebesta with C. Buongiorno (Rome, 23/6/92) and L. Broglio (Rome, 22/6/92), ESA archives, EUI, Florence.

[18] The performance aims of the European launcher, as described in the original Anglo-French proposals circulated in February 1961, were the following: a) a large satellite (mass between 500 and 1000 kg) to be put into a near-circular, low orbit (300-500 km), with the primary aim of making astronomical observations above the earth's atmosphere; b) a smaller satellite of a few hundred kg, to be put into an eccentric orbit (apogee up to about 18,000 km), for the study of the earth's gravitational, magnetic and radiation fields and the constitution of outer layers of the atmosphere; c) a small satellite of some 50 kg mass, to be put into a high eccentric orbit (apogee up to about 170,000 km), for the study of the sun's atmosphere.

[19] ELDO (1966).

To further entice the 'small' countries, Britain suggested that the benefits of her extra contribution be divided among them, so reducing their share of the total cost of the IP, while France, West Germany and Italy would pay shares equal to their percentage contribution to CERN.[20]

Finally, after nine months incubation, at the Lancaster House conference (London, 30 October-1 November 1961) the momentous decision was made to give birth to ELDO for the realization of the IP. There the delegates discussed in detail the technical definition of the IP and agreed in principle on a "functional breakdown" of the work assigning to each of the partners their specific responsibilities.[21] They also adopted the schedule for the IP proposed by Britain and France in February 1961, including the timescale of flight trials. It included the launching of ten vehicles in three phases: phase 1 (1962-63): three launchings of *Blue Streak* alone; phase 2 (to be completed by the end of 1964): three launchings of a three-stage vehicle with dummy upper stages; phase 3 (during 1965): three launchings of the complete vehicle. The realization of this programme presupposed, however, that the work of ELDO would be started immediately.[22] Moreover, following a proposal advanced by the Italian delegation, it was agreed to set aside £2 million in the IP in order to undertake, in parallel with the development of the IP, a two-year study of future possibilities and requirements for more advanced launchers and ranges, to be concluded by a report about a possible re-orientation and/or upgrading of the IP.[23]

Another main point discussed at the Lancaster House conference was resources. There was already uncertainty about the validity of the cost estimate (£ 70 million) of the IP, and the delegates discussed about how to finance any overexpenditure that might become necessary in the future. Finally the delegates agreed that, if some of the states present at Lancaster House decided not to become members of ELDO, the governments of France, West Germany and the UK would negotiate among themselves how to meet the consequent shortfall in contributions

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20 De Maria & Krige (1992), p. 114; Krige (1993a), pp. 19-22. The percentage contributions of the other 'big' member states were: France, 20.57 %; West Germany, 18.92 %; Italy, 9.78%.

21 Britain and France, as we know, were to deal respectively with *Blue Streak* and *Véronique/Coralie*. West Germany was given the responsibility, in a specific protocol, for development and construction of the third stage. Italy had the task of building the first series of test satellites, including their electronic equipment. Belgium was to supply down-range ground guidance stations. The Netherlands was given responsibility for the supply of long-range telemetry links. Finally Australia was to furnish the testing site at Woomera for trial firings of the first stage and the launcher. Tassin (1970), p. 25; ELDO (1966).

22 ELDO (1966), p. 64 .

23 *ELDO Convention*, Article 16; see also ELDO (1966), p. 9.

arising from possible withdrawals. "This was tantamount to a commitment on their part to make good any such deficit".[24]

As to the criteria to be adopted for the free circulation of technical know-how — a delicate topic indeed because of its potential military and strategical relevance — it was finally agreed "after lengthy deliberation" that all the technical know-how arising from ELDO's programmes could be used free of charge by the member states and "by persons under their jurisdiction, whether individuals, companies or organizations for their specific needs in the space area".[25]

At the end of the Lancaster House conference, Thorneycroft released a press conference where, apparently for once lacking the British virtue of understatement, he presented the inception of ELDO as "probably the biggest technological effort any group of nations has attempted in history". Then, with much clearer political far-sightedness, he went on explaining that the creation of ELDO was necessary in order to "avoid a situation in which Europe is right out of the launching of any satellite in the future". Moreover, ELDO would have given Europe "an opportunity, which otherwise would have been denied to us, of taking some part in the commercial exploitation of space". "One does not know", he concluded, "ten years ahead what this will be, but if we waited ten years we would not be in the field."[26]

On 29 March 1962, three months before the signing of the convention of ESRO, the ELDO convention was signed by six European countries (UK, France, West Germany, Italy, the Netherlands and Belgium) and by Australia, the operator of the Woomera missile range. The convention was accompanied by two annexed protocols, a "Financial Protocol", and a "Protocol concerning certain responsibilities in connection with the Initial Programme", which were "an integral part" of the convention itself.[27] The entry into force of ELDO convention and its protocols could become effective after ratification by States the total of whose contributions amounted to at least 85%.[28]

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[24] ELDO (1966), p. 10.

[25] *Ibid.*

[26] Press Communiqué, *Spaceflight, 4:1* (January 1962), p. 1.

[27] *ELDO Convention*, Art. 26; the two protocols were referred to in Art. 18(2) and Art. 16(1), respectively. ELDO (1962).

[28] *ELDO Convention*, Art. 28(1), *ibid.*

According to the ELDO convention, the Members of the Organization "shall be the States who sign and ratify it"[29]. But six European countries, which had taken part in the early conferences which led to the foundation of ELDO, eventually did not join it: the "neutrals" (Austria, Sweden, Switzerland) took this decision because they were uneasy over the military implications of the proposed civil heavy satellite launcher, its technology being the same of ICBMs. Norway, for its part, felt that it did not possess the minimal technical means that would allow for a useful co-operation in ELDO's IP. Other European countries (Spain, Denmark) did not join ELDO because of the high costs.[30]

The fact that six States did not sign the convention meant a shortfall in contributions. Consequently, negotiations took place during 1963 between France, West Germany and the UK, as agreed on at the Lancaster House conference. After lengthy negotiations they finally agreed to share the missing contributions in proportion to their percentages in the previous scale for the IP. According to the new scale the already heavy price paid by Britain for her leading role in ELDO was increased from the initial 33% to the huge figure of almost 39% of the total expenditure.[31]

3. ELDO's convention vs ESRO's convention

The ELDO convention resembled that of ESRO only superficially. The decisional structures of the two organizations were apparently the same: both were governed by a Council to which decisional responsibility and political authority was given. However, there were deep differences which were to play a crucial role in the different destiny of the two Organizations.

ELDO's aims, as specified in its convention, were "the development and construction of space vehicle launchers and their equipment suitable for practical applications and for supply to eventual users", while it was further stipulated that "the Organization shall concern itself only with peaceful applications of such launchers and equipment".[32] As to the potential users, they

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29 *ELDO Convention*, Art. 3(1), *ibid.*

30 Tassin (1970), p. 25; Schwartz (1979), p. 210.

31 The percentage contribution of France was increased to 20.57%; that of Germany to 18.92%, while that of the other partners remained unchanged.

32 First quotation from *ELDO Convention*, Art. 2(1); second quotation from Preamble, Art. 2(2) and 9, ELDO (1962).

could be, as defined in the convention, either the member states themselves, or non-member states and international organizations.[33]

It should be stressed, however, that although three articles of the convention were devoted to the possible users of the future European launcher, a complete vagueness as to the ultimate uses of the launcher and its eventual commercial outlet characterized the inception of ELDO, as testified by the lack of any definite programme of missions or any other concrete purpose in its convention. It is true that its performance aims, as described in the Anglo-French proposal informally circulated in February 1961, appeared to be concerned only with scientific satellites, but no trace of it survived in ELDO convention.[34] Moreover, the ESRO convention included in its aims the "successful launching, from the sixth year of its existence, of two fully instrumented space probes or major satellites (i.e. requiring large launching vehicles)", and it was well known since 1962 that the ESRO Large Astronomic Satellite (LAS) required an equatorial launching site; however, only in the second half of 1966 ELDO agreed in principle on whether and where to build such a site. In other words, ELDO was born as an organization without definite users and a clear programme of missions to be accomplished by its IP launcher. The early period of delay in determining its objectives (in marked contrast with ESRO, whose scientific aims were well defined in the convention) was charged with important implications for the future of ELDO.[35]

A second major difference in the structure of the two sister organizations, as originally conceived, explains their different destiny. In the case of ELDO, most of the work on *Blue Streak* and on *Véronique* was already in hand well before the signature of the convention, and relevant contracts had been placed by the respective governmental agencies. Consequently, it was quite natural for Britain and France to continue to manage contracts on the basis of their acquired experience. This *de facto* situation heavily influenced ELDO's structure, since both the British and the French had to continue to finance their national efforts pending the ratification of the convention (in particular the British, who had to keep *Blue Streak*'s teams working while the complex political and bureaucratic formalities were resolved in connection with the signature and ratification of the ELDO convention). Therefore ELDO Member States, under the pressure of the French and the British, took the view that the best way of shouldering their

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[33] *ELDO Convention*, Art. 9 and 11, *ibid.*

[34] See note 18.

[35] *ELDO Convention*, Art. 9-11, ELDO (1962); *ESRO Convention*, Command 1840, ESRO (1962). There had been some discussion on a report by the British Post Office, where 3 to 4 launchers a year were possibly needed to put communication satellites into high orbits, but no concrete initiatives ever ensued. Estimates Committee (1966), pp IX-X; see also Hochmuth (1974), p. 66.

specific tasks and responsibilities in the IP was through contracts placed by themselves. Consequently, a system of "leadership", established in the "Protocol concerning certain responsibilities in connection with the Initial Programme", was assigned to national governments and their industries. The ELDO convention institutionalized this procedure: "Whenever the Member States to which work is allotted so desire, contracts for carrying out the initial programme shall be placed by the government according to its procedures [...] Such contracts shall be carried out at the expense of the Organization". It is also true that the ELDO convention gave its secretariat corporate status and authorised it to place contracts, but only "in agreement with the government of the Member State in whose territory the work is to be carried out".[36] No wonder, then, that the system of contracts to be placed directly by member states, as stated in the ELDO convention and the Protocol concerning certain responsibilities, had many drawbacks: differences between one country's system of contracting and another's, dispersal of effort, lack of co-ordination, etc.[37]

ESRO, on the contrary, did not have such problems: its convention gave the organization corporate status and authorized it to design and construct facilities, provide means for collection and analysis of data and make contractual agreements for the use of launching facilities. Moreover, in a later protocol signed in October 1963 the Organization was authorized to enter into contracts, acquire fixed and movable assets and institute legal proceedings.[38]

This structural difference in contracts between the two organizations was reflected also by an apparently less gaudy difference: while ELDO had a *Secretary* General who was designated "*principal* executive officer", ESRO had a *Director* General who was its "*chief* executive officer" and legal representative of the Organization. Moreover, ESRO staff members, selected — as in the CERN case — on the basis of their competence and qualification "taking into account adequate distribution of posts among Member States", were appointed by the Council on recommendation of the DG and were not allowed to ask or receive "instructions from any government or from any authority external to the Organization".[39]

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[36] *ELDO Convention*, Art. 6(1) and 6(2); Art. 16(1) and 16(2); *Protocol concerning certain responsibilities in connection with the Initial Programme*, as referred to in Article 16(1). See also ELDO (1966), pp. 40-42.

[37] *ELDO Convention*, Art. 6, ELDO (1962) ; cfr. also ELDO (1966), pp. 39-40.

[38] *ESRO Convention*, Art. 14 and 5, ESRO (1962).

[39] ESRO, *Basic Texts/Rules and Regulations/Agreements*, Doc. SP-4 (Paris: ESRO, March 1969), p. 50.

Another difference between the two organizations consisted in the fact that their authority stemmed from different political sources: while the members of COPERS who framed the ESRO convention after the successful experience of CERN were either members of the European scientific community or science administrators and bureaucrats from national ministries concerned with science, most of the national delegates who took part in the early conferences where the ELDO convention was framed (and later in the ELDO Council) received their authority from different ministries, like those of Aviation, Finance and Economics, or Foreign Affairs — although in some cases the same people represented national governments in both organizations, as in the case of Belgium, France, Italy, and, later, of Germany.[40]

In conclusion, ELDO was born as a multi-headed child who was to struggle to his feet impeded both by internal, structural fragilities and, as we shall see later more in detail, by external political obstacles, with the aggravating circumstance that its seven heads were not at all equally developed.

Its decentralized structure left to ELDO's Secretariat "very little power in respect of the technical and financial management of the project", as stressed ten years later by the liquidator of ELDO, General R. Aubinière in his *de profundis* of the Organization.[41] According to Hermann Bondi, Director General of ESRO between 1967 and 1971, this seven-fold managerial arrangement had also been determined by the belief that, in those times, "launch vehicles were still supposed to have some military significance". Therefore, according to Bondi, "[ELDO became] a perfect machinery, for [cost] escalation, with the added difficulty that all [was] run by a central organization without finance or management powers, rightly calling itself only a secretariat. Of course it could not work[...]. It was clearly an impossible management structure and, in one way or another, every launch attempt was a failure".[42]

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[40] Tassin (1970), p. 90. See also Hochmuth (1974), p. 65.

[41] Aubinière (1974), p. 10.

[42] Bondi (1973), p. 19.

4. The inception of ELDO and the European Space Industry: the foundation of EUROSPACE

Prior to the inception of ESRO and ELDO, continental electronics or aviation industries, though involved in building their advanced planes, had little or no experience in large rockets or spacecrafts, possibly with the exception of France.[43]

By 1960, Britain was the only country, with the exception of Gaullist France, with a national space programme which was "easily the largest undertaken by any European country". Although it did not include an independent satellite launching capability, it comprised a large range of activities and projects including sounding rockets (*Skylark* and *Black Knight*)[44], the optical and radio-tracking of satellites and space probes[45], and design of satellites and their probes. This last task had been undertaken by groups from both universities and government establishments co-ordinated and assisted by the British National Committee for Space Research (NCSR) set up by the Royal Society in December 1958 under the chairmanship of H.S.W. Massey. In addition the British Post Office was also collaborating with the US in testing experimental telecommunication satellites.[46] Finally, in June1959 British scientists established a joint programme with the USA for satellite launching, later to be called the *Ariel* programme.[47]

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[43] Gilpin (1968), p. 392; Hochmuth (1974), p. 67.

[44] *Skylark* was a solid fuelled rocket of 8 meters long and capable of carrying a 50-70 kg payload up to an altitude of 160 km. It was very cheap and reliable: by 1960, over twenty successful experiments had been carried out with it, providing valuable information on upper atmosphere winds, temperature and electron density. The *Skylark* rocket programme was run by Great Britain in close co-operation with Australia, using the Woomera rocket range. For further details see Massey & Robins (1986), ch. 3. For the *Black Knight* programme see note 4.

[45] During the International Geophysical Year Britain had played a very important role, notably by tracking the first *Sputnik* satellites at Jodrell Bank and by receiving telemetered signals from the US *Explorer* satellites. The Jodrell Bank radiotelescope was still, by 1960, the first apparatus in the world for reception of radio signals from US space probes.

[46] Massey & Robins (1984), ch. 5.

[47] The origins of the *Ariel* programme can be traced back to a meeting of COSPAR (the Committee on Space Research of the International Council of Scientific Unions) held in The Hague on 14 March 1959. There the US delegate announced that NASA would be prepared to launch, free of charge, scientific equipment for scientists of other countries. British space scientists were quick to jump on the NASA bandwagon. In late June 1959 an official British delegation led by Massey visited NASA headquarters with detailed projects of eleven experiments suitable for launch by NASA within about two years. There Massey reached a provisional agreement with NASA officials for the launching of three satellites containing British experiments, starting in 1961 at intervals of about one year. This bilateral agreement, as Massey & Robins laconically commented, "reduced the emphasis from the point of view of [British] space science on the provision of an all-British launching system". Massey & Robins (1986), p. 73.

If British space scientists could consider themselves more than satisfied by both the bilateral agreement with the US and by their future participation in the ambitious scientific programmes envisaged for ESRO, British aerospace industries saw their future much more bleak. Therefore, the powerful British aerospace lobby (de Havilland, Hawker-Siddeley, Rolls-Royce, Saunders-Roe and Sperry Gyroscope Company), already actively involved in the development of *Blue Streak*, entered into action, getting in touch with their counterparts in continental Europe and started to put co-ordinated pressure on their respective governments, aimed at the adoption of a European space programme centred on the building up of an all-European heavy satellite launcher.

As early as September 1960, when Thorneycroft was visiting European capitals in search of support for the Europeanization of *Blue Streak*, the British Member of Parliament David Price, a strong supporter of the British aerospace industry and early paladin of European technological integration, presented to the Consultive Assembly of the Council of Europe a comprehensive report on "European Co-operation in Space Research and Technology". In his report Price outlined the probable technical benefits of space research, placing special emphasis on satellites for communication, navigation and meteorology, and described the ongoing design studies on the adaptation of British military rockets for "peaceful" space research. Then he presented a twelve-point plan to be adopted "courageously" by the European countries, spread over a minimum of ten years, as in the case of the NASA programme, with a "reasonable continuity" in the scale of effort and the finance provided.[48]

As a result of Price's report, the Consultative Assembly of the Council of Europe (representing the parliaments of fifteen European countries, but not the governments) unanimously passed a resolution containing a list of recommendations to the Committee of Ministers, asking them "to prepare a specific plan for the creation of a European Space Agency and submit it to member-Governments for early ratification". The first recommendation, regarding an all-European satellite launcher, invited the Ministers to study "as a matter of urgent policy the possibilities and cost of setting up a European agency to undertake a space programme, based upon a space vehicle developed and built in Europe, and to promote peaceful uses of outer space".[49]

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[48] Price's plan coincided almost entirely with the proposals placed before the UK Prime Minister by the British Interplanetary Society in March 1960, i.e. one month before the cancellation of *Blue Streak* as a military weapon. *Spaceflight, 3: 1*(January 1961), 5-8.

[49] *Ibid.*, p. 5.

Four months before the Lancaster House conference, on 26-28 June 1961 the British Interplanetary Society organized a European Symposium in London, which was attended by more than 200 delegates from Britain and other European countries. On this occasion top-rank representatives of the British aerospace industries strongly campaigned in favour of accepting *Blue Streak* as the first stage of an all-European launcher: Air Commodore F.R. Banks, of Hawker-Siddeley Aviation, warned against "a too selfish and national outlook" in space, pointing to a "sublimation of national interests" as a primary aim for the success of a European space programme.[50] In a similar Europeanistic vain, the chief engineer of Rolls-Royce Rocket Division, A.V. Cleaver, admonished that "if we in Western Europe have no [space] programme [...] the consequences would be disastrous [...] It is not good enough to hitch a ride on US or USSR research vehicles. There can be no scientific continuity if we rely on other powers; we must have a high degree of independence". On a more concrete basis, the Chief Weapons Research Engineer of de Havilland, Pardoe, pointed out the future economic benefits of a joint European space effort. He indicated weather, navigation and communication satellites as being of practical commercial use in a near future, adding that "European governments must now surely realize that space will pay dividends — not intangible military dividends [...] but real, practical dividends".[51]

Also on this occasion Price supported the views of the British aerospace lobby for both political and economic reasons. As to the political implications of space, "a space race", he maintained, "is taking place between the communist world and the Western world. [...] The American 10-year programme is something more than a programme of scientific research. It is a major exercise in power, present and future. [...] Basically our decision as to what we in Europe ought to do about space has to be taken in the light of what role we think we can and ought to play in the world of to-morrow. Influence flows from power [...] and space is an increasingly important ingredient in power".[52]

As to the economic benefits, according to Price, European co-operation in space was an obligatory path particularly for 'small' European countries: since for them the "economic implications" of entering space were "frightening", "the only way of obtaining a share in space research and space technology is to join together in a space consortium". Finally, he strongly supported the development of an autonomous European satellite launching capability because, on the one hand, there was little evidence that the USA or the USSR would be willing to sell

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50 *Aviation Week* (3 July 1961), p. 30.

51 *Aviation Week* (10 July 1961), p. 23.

52 Price (1962), pp. 9-10.

appropriate space vectors to European countries "for our independent use"; on the other, he argued, "many of the technological benefits of a space programme flow from the development of the space vehicle and the propulsion system of one's own. Riding into space on an American vehicle would be a very poor 'second best' ". Thus, he concluded, scientific co-operation with the USA or the USSR would be better effected by Europe having its own independent programme rather "than waiting expectantly and pathetically for space crumbs which may fall from the rich man's table".[53]

The project of the British aerospace lobby for the foundation of a European space consortium, centred on salvaging *Blue Streak* as a satellite launcher, was enthusiastically accepted by the delegates from other European countries. Speaking for all at the end of the meeting F. Vinsonneau, of the French company SEREB, commented: "What we did say, and repeat with conviction, was that the only solution in the [space] field was a united Europe [...] Experiences and methods gained by the United Kingdom formed a large part of our common fund of knowledge and it would be our duty to support them and to prevent their dispersal".[54]

European industry as a whole was thus ready to accept the challenge, and immediately started to organize its supranational lobby EUROSPACE (Groupement industriel européen d'études spatiales). This body was officially founded on 21 September 1961 as a non-profit association with headquarters in Paris. Its initial subscribers were 47 companies or trade associations from Belgium, France, Italy, the Netherlands, the UK and West Germany. Its members included all the leading European companies in aircraft and missiles manufacture, and the most important industries in electronics, chemistry and materials, steel and machinery (e.g. precision equipment). By April 1962, when the ELDO convention had just been signed, the number of companies grouped in EUROSPACE, either directly or through trade associations, had reached one thousand, 81 of which were individual members with a labour strength of more than one million workers.[55]

EUROSPACE, according to Article1 of its constitutive statute, aimed to "promote the development of aerospace activities in Western Europe. Its object [was] to study, on a European and international level, the technical, economic and legal problems facing the industry as a

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53 *Ibid.*, pp. 11 and 13.

54 See note 50, p. 31.

55 Chairman of AEROSPACE was J. Delorme, who was chairman and general manager of Air Liquide. Its general secretary was J. Vinsonneau of SEREB. Its vice-presidents were M.N. Golovine, general manager of Hawker Siddeley Aviation, and Dr. Rothe, chairman of the Bundesverband der Deutscher Luft- und Raumfahrtindustrie (BDLR). See "Eurospace: General Information", ESA archives, EUI, Florence, box 2884.

result of exploration and exploitation of space, and all related questions".[56] In short, EUROSPACE offered its services as a valid interlocutor to both national governments and to the still unfledged ESRO and ELDO, as "a valid representative of industry to such organizations", aiming to "help them efficiently to carry out their space programmes".[57]

5. The Preparatory Group and the slow incubation of ELDO

At the Lancaster House conference national delegations, recognizing that the signature and ratification of the convention might take many months, drew up a protocol, to be signed simultaneously with the convention, establishing the immediate constitution of a Preparatory Group (PG). This temporary body had the twofold objective of preparing detailed plans and arrangements "for setting up of the Organization", pending Governments' decisions on the Convention, and of co-ordinating the work of the IP already in hand or capable of being under way in the interim. In particular, the PG was given the task of inviting member Countries "for the placing of contracts for the various parts of the programme on which work was not yet started". Since the protocol establishing the PG entered into force immediately, regardless of the time needed for the ratification of the convention, the underlying concept was that the activities co-ordinated by the PG were to be undertaken by member states "at their own expense and risk". The PG held its first meeting as early as December 1961, without even waiting for the protocol establishing its formal constitution to be signed. On that occasion the PG elected General E. Cigerza (Italy) as its Chairman and set up a Technical Committee (TC), chaired by W.H. Stephens (UK), and an Administrative Committee (AC), chaired by M. Depasse (Belgium).[58]

Immediately after the constitution of the PG, it became clear that a permanent Secretariat for the PG (prefiguring in embryo the future ELDO's Secretariat General) was badly

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56 *EUROSPACE Statutes*, Annex to ELDO/PG/Secr. 69, 31/5/62, ESA Archives, *ibid.*

57 To this end EUROSPACE set up four working groups to deal with: a) industrial property (e.g. problems arising in matters of patent rights); b) information (with the task of setting up "definite proposals in order to ascertain what would be the permanent EUROSPACE policy, in close co-operation with intergovernmental agencies [ELDO and ESRO]"; c) technical programmes (with the task of elaborating proposals regarding "the study and evaluation of space systems (including launchers) and of the required ground installations"; d) overall programmes and budgets (with the task of analysing the Western European possibilities "in the financial, economic and industrial fields"). See note 55, p. 3.

58 Press communiqué, note 26, p. 1. ELDO Preparatory Group, first meeting (11-13/12/61), ELDO/PG/1ère Réunion, 18/12/61, ESA Archives, EUI, Florence, box 1815; Eldo Preparatory Group, *Report by the Technical Committee*, ELDO/PG/13 (Revised), 13/12/61, *ibid.*, box 1817. See also ELDO (1966), p. 11.

needed. Therefore, in February 1962 the Secretariat of the PG was set up and initially established its headquarters in London. M. Depasse, who was chairman of the AC, was appointed Head of the Secretariat and J. Renou (France) took over his duties as chairman of the AC.[59]

In June 1962, the Secretariat moved its headquarters from London to Paris with the help of the French CNES, which actively co-operated in finding and equipping the PG's offices in Paris. On 30 October 1962 the Secretary General, Ambassador R. Carrobio di Carrobio (Italy) attended for the first time a meeting of the PG. On that occasion General Cigerza resigned the chairmanship of the PG, and D.W.G.L. de Havilland (UK) was elected as his successor. A few weeks later, W.H. Stephens and H.L. Costa took up their respective duties as Technical Director and Administrative Director, while G. Boch (FRG) took over Stephens' duties as chairman of the PG's TC.[60]

The TC's priority tasks were related to the co-ordination of the IP, the setting up of the launch facilities, the guidance system and the satellite test vehicle. It was moreover given the task of initiating the studies on future programmes. While it existed, the TC held twelve meetings and was assisted in its work by the establishment of a Technical Planning Staff (TPS), to be considered as the precursor of ELDO Technical Directorate.

The TC developed, among other tasks, optimization studies aimed at improving the performances of *Europa 1*[61], and completed the distribution of work among member states on the attitude reference system (West Germany and the Netherlands), telemetry and the equipment of the satellite test vehicle (the Netherlands and Italy).[62] The TC also analysed different future options aimed at improving the performances of *ELDO-A* (*Europa 1*), in order to answer the needs of ESRO's LAS and to be able to launch high-orbit telecommunication satellites. Finally, it advanced a "short term" solution, consisting in the addition of an apogee motor as fourth stage, and a "long term" solution, based on the replacement of *ELDO-A*'s upper stages with high-energy stages (*ELDO-B*), and suggested that the new programmes should start before the

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59 ELDO Preparatory Group, ELDO/62/PG/PV 1, 15/1/62; CECLES/PG/PV 2, 17/1/62; ELDO/PG/PV 3, 21/2/62; CECLES/PG/A/1 (Révisé), 16/1/62; ELDO/PG/T/2nd Meeting, 16/1/62; ELDO/PG/T/3rd Meeting, 1/3/62; ESA Archives, EUI, Florence, box 1815 and 1817.

60 ELDO Preparatory Group, ELDO/PG/PV 5, 12/7/62; *Structure Provisoire jusqu'à Mars 1963*, Note du Rapporteur britannique "Structure", ELDO/PG/A/81, 14/9/62; ELDO/PG/T(62) 6th Meeting, 29/10/62; ELDO/PG(63), 21/2/63; *ibid.*, box 1815 and 1817.

61 ELDO/PG(63)T/25 and ELDO/PG(63)T/26, to become respectively the first and the second part of PG's general report on the IP, *ibid.*

62 ELDO/PG(63)T/27, to become the third part of PG's general report on the IP, *ibid.*

end of 1964, in order to avoid any "discontinuity" with the completion of the IP and to satisfy in time the needs of potential users.[63]

However, the TC's proposals for future programmes were to remain wishful thinking still for many years to come. ELDO's early unpreparedness is testified by its officials' cold reaction to the comprehensive space programme presented by EUROSPACE in April 1963. This programme, agreed upon by 110 "active" member firms in eight European countries[64], was the result of a study which lasted for more than one year. The vice-president of EUROSPACE, M.N. Golovine, presenting it in a press conference held in London on 8 April 1963, maintained that "we have featured what we think are the most important tasks, [but] in the final analysis space projects can be undertaken only by governments, not by industry".[65] The EUROSPACE programme included, among other proposals for a distant future (e.g. lunar landings, Martian probes, etc.), the development of an all-European telecommunication satellite system, considered as "the most immediate task".[66]

On 17 June 1963 a meeting took place between ELDO top officials and EUROSPACE representatives.[67] During that meeting EUROSPACE's vice-president, Golovine, stated clearly that the EUROSPACE plan aimed at "defending an increasing participation of European industry in the development and production of hard work for a world telecommunication system

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63 ELDO Preparatory Group, TC meeting (30-31/5/63), ELDO/PG(63)T/PV/2, 19/6/63, pp. 10-11; TC meeting (27/9/63), ELDO/PG(63)T/PV/3, 17/10/63, pp. 9-10; TC meeting (28-29/11/63), ELDO/PG(63)T/PV/4, 16/12/63, pp. 11-12; TC meeting (7/2/64), ELDO/PG(64)T/PV/1, 18/2/64, pp. 8-10; TC meeting (24/4/64), ELDO/PG(64)T/PV/2, 27/5/64, pp. 7-9, *ibid.*, box 1817.

64 Belgium, France, Italy, the Netherlands, Norway, Switzerland, United Kingdom and West Germany.

65 *The Times*, 9 April 1963.

66 The EUROSPACE programme included both a non-stationary and a stationary satellite system. The non-stationary system was based on the use of twelve satellites, with a payload of between 200 and 400 kg, in circular orbits at an altitude of approximately 7,600 miles. The suggested launch vehicle, in its early firings, was ELDO's *EUROPA 1* (named "*ELDO Able*" in EUROSPACE jargon). The envisioned total cost of this system, including both research and development, was approximately $542 million distributed over eight years.
The stationary system consisted of two geosynchronous satellites, with a payload of between 250 and 500 kg. The two up-graded launchers (christened *ELDO Baker* and *ELDO Charlie*) envisioned for the geosynchronous system were to be operational in 1968-69 and in 1970-71, respectively. Its total cost was estimated at $249 million. EUROSPACE:"*Propositions pour un Programme Spatiale Européen. Résumé*", ESA Archives, EUI, Florence; see also C. Brownlow, "West Europe Firms Pushing Space Efforts", *Aviation Week and Space Technology* (8 April 1963), 38-39; *The Times*, 9 April 1963.

67 The EUROSPACE delegation included, among others, its general secretary Vinsonneau and its vice-president Golovine; the ELDO delegation included PG's secretary Depasse and its technical director Stephens.

[...] permitting the introduction in such system of European satellites and then of European launchers".[68] But PG's technical director Stephens cooled down EUROSPACE enthusiasm explaining that during the interim period before the ratification of the ELDO convention it was possible for his Organization to enter only "into informal relationships" with other bodies like EUROSPACE. Although he agreed on "the necessity of indicating clearly ELDO's interest in producing launchers for telecommunications", he concluded that "the question had now become political and it was for the European governments to resist certain American tendencies under which the US would rent Europe the use of American systems".[69]

It should be stressed, however, that ELDO officials' coldness in front of EUROSPACE proposals was not simply due to the PG's lack of decisional power. The main reason must be identified in the fact that ELDO was born, according to its founding convention, for the realization of the IP, i.e. of a low orbit satellite launcher, *Europa 1*, which could not be used for telecommunication satellites.

As to the Administrative Committee (AC) of the PG, it had the priority task of drawing up urgent measures regarding diplomatic and legal texts regulating the activities of the PG and later of ELDO, upon the entry into force of its convention. By May 1962 the AC had obtained the PG's approval of its proposals on the structural functioning of ELDO: among them, a "detailed breakdown" between the Technical Directorate (TD) and the Administrative Directorate (AD), with a combined strength of 152 staff. Moreover, with the help of groups of experts, the AC drew up the rules of procedure for the ELDO Council, the financial rules for ELDO, contracts and security regulations, the ELDO staff statute, a protocol on privileges and immunities and a patents protocol.[70]

The accomplishment of tasks by the PG's committees was, however, complicated by the lack of a sufficient and suitably qualified administrative and technical staff particularly during the first year of activity. In fact, the Protocol establishing the PG prescribed that "the Governments shall endeavour to make [...] staff available to the Preparatory Group. In the first instance, they shall be responsible for the remuneration of their nationals so made available to

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68 ELDO: "*Notes on discussion with representatives of EUROSPACE, 17/6/63*" (4/7/63), and attached *Memorandum* (2/7/63), ESA Archives, EUI, Florence.

69 *Memorandum*, note 68, p. 3.

70 To this end, eight sub-groups, chaired by experts-rapporteurs, were set up on the following topics: 1) structure; 2) personnel; 3) finance; 4) contracts; 5) industrial property; 6) privileges and immunities; 7) security; 8) rules of procedure for the PG and the Council; ELDO (1966), p. 12. See also ELDO Council, 1st session (5-6/5/64), ELDO/C(64)PV/1, 22/6/64, p. 10.

the Preparatory Group." Consequently, by the end of 1962 national governments succeeded in putting a total of only 53 staff at the PG's disposal, quite insufficient to guarantee even a minimal functioning of its structures.[71]

Moreover, during the 29 months of its existence the PG was seriously handicapped by its lack of legal personality, which prevented it from being able to make any financial commitment (like the signing of contracts for feasibility or development studies, staff recruitment, etc.) and, in general from taking any decision except by unanimity, "relying upon the good will of Member States to see that it was enforced". This situation, notwithstanding the "conciliatory approach" adopted by member states determined serious delays in the approval of PG's yearly budgets, which worsened its poor functioning. Thus, the 1961-1962 administrative budget was approved only in May 1962 and the technical budget in October 1962; the administrative budget for 1963 was approved in February 1963 and the technical budget in July 1963. For 1964, only the "strenuous efforts" of the Secretariat allowed the whole budget, both technical and administrative, to be finally approved by December 1963.[72]

The PG had also to determine the conditions governing ELDO operations in Australia, where the Australian government, under the ELDO convention, had to make available both the range and supporting facilities of Woomera and to guarantee technical co-operation in conducting trials and assessments for the IP. As early as the summer of 1962 a "Trials Planning Mission" was sent to Australia.[73] Two other missions were later sent to Australia in June 1963, to study guidance and telemetry questions, and in March 1964, to study the installations designed for the second and third stages of the launcher. Because of the complexity of the issues at stake, it was finally agreed that Australia's initial commitment should provisionally regard only the first phase of the IP, i.e. the firings of *Blue Streak* alone.[74]

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71 The staff units increased up to 110 by the end of 1963, and to 138 by 30 April 1964, when the PG's activities officially ended. ELDO (1966), pp. 11 and 29-30.

72 ELDO (1966), pp. 12-13.

73 ELDO Preparatory Group, PG meeting (11-12/7/62), ELDO/PG/PV/5, 12/7/62, p. 7, ESA Archives, EUI, Florence, box 1815.

74 ELDO Preparatory Group, PG meeting (27-28/6/63), ELDO/PG(63)PV/2, 11/7/63, p. 2; PG meeting (29/10/63), ELDO/PG(63)PV/3, 12/11/63, p.2; *Note sur l'Organisation des Travaux Techniques de l'ELDO en Australie*, Note du Secretariat, ELDO/PG(63)T/33, 20/11/63; PG meeting (25/2/64), ELDO/PG(64)PV/1, 13/3/64, p.5; PG meeting (29-30/4/64), ELDO/PG(64)PV/2, 20/5/64, p. 2; see also the introductory report by the president of PG's Technical Committee, G. Bock to the first session of the Council: ELDO Council, 1st session (5-6/5/64), ELDO/C(64)PV/1, 22/6/64, pp. 17-19.

Notwithstanding all the difficulties previously underlined, engineering work on the development of the various components of the launcher, optimization and control systems, the satellite test vehicle, guidance, telemetry and attitude reference systems, was initiated or continued in various member states. However, for the reasons previously set out, during the long interim of the PG the work on the IP proceeded at a much lower pace than initially expected, and it did not take long before the PG started to realize how optimistic the schedule of the IP drawn up in 1961 had been. Thus, in April 1962 a new timescale for the IP was defined by the PG's TPS, where the new key dates were fixed as follows: 1 May 1962, full start of the development programme; 1 November 1963, first launch of *Blue Streak*; 1 March 1966, first orbital firing of the complete *Europa 1* (F7); 1 December 1966, completion of the IP. Finally, in April 1964 the PG's TC presented, in its last meeting, a revised timescale where F7 was postponed to the Fall of 1966 and the completion of the IP to 1967.[75]

6. Starting work in member states

Initial delays and slippages in the take-off of the IP were due, as previously stressed, to the decentralised structure of the Organization, which made it function more as a *collage* of national programmes rather than as a centrally directed supra-national agency, as in the case of ESRO. Under the ELDO Convention, each member state had to fulfil at national level the managerial functions for the part of work on the IP assigned to it; this determined insurmountable difficulties in the control, both technical and financial, by the PG, which was merely a co-ordinating body without legal authority and which had to rely on national governments to implement any action it directed.

Another initial difficulty stemmed from the fact that only Britain and France, because of previous developments of their military national programmes, had some experience in space technology and knew how to supervise high technology contracts for research and development in this field. Other member states, which had little or no knowledge in cost-type contracts, limited their action to transmit the requirements of their contractors (for whom, according to the ELDO convention they had "leadership responsibility") to the PG's Secretariat without any previous scrutiny or control.

The situation was worsened by the great disparity in the state of development of the various parts of the IP assigned to member states, ranging from the quite completed *Blue Streak*

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75 Annex A to ELDO/PG/Secr. 79, 6/6/62; ELDO Council, 1st meeting, note 70, p. 18.

to the totally new Italian test satellite or the German third stage, which reflected a similar disparity in the experience of national firms involved.

Finally, early time slippages were due to the climate of uncertainty in which national industries were obliged to work pending the ratification of the Convention. As A.V. Cleaver, Chief Engineer of the Rolls-Royce's Rocket Propulsion Division commented in May 1964, because of this uncertainty "one of the major problems which has arisen throughout the project, therefore, has been the maintenance of adequate morale throughout a far-sized engineering team, in order to carry through successfully a quite difficult programme of design and development, including the development of all the necessary testing techniques and facilities".[76]

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Let us now analyse the early difficulties and delays in the work on the IP in member states.

In Australia, although *Blue Streak* had been accepted in principle as the first stage of the European launcher since November 1961 and by that time the facilities for its launching at Woomera were in "an advanced state of completion", the launch pad developed by the Australian Department of Supply's Weapon Research Establishment (WRE) was not completed until the end of 1963.[77]

In Britain, the engineering work needed for the re-shaping of *Blue Streak* from its original ballistic role to that of a satellite launcher first stage proved to be more slow and difficult than expected. In fact the first, complete *Blue Streak*, F1, reached Woomera for its first full static firings only by Christmas 1963. The "big event", i.e. its first live firing was re-scheduled a number of times and finally fixed for 25 May 1964. However that day the countdown was halted two and a half hours before the firing owing to bad weather conditions. There was a new set-back on the new date, 2 June 1964, when the rocket's engines were stopped automatically only three seconds before the launch because of a "fault of obscure nature" in the safety system of both the rocket and the ground installations.[78]

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[76] Cleaver (1964), on p. 474.

[77] Among other work, the launch tower was to be extended to a height of 133 feet in order to host the complete three stage launcher. Stubbs (1963).

[78] *The Times*, 26 May 1964; *The Times*, 3 June 1964.

A "textbook launching" finally took place on 5 June 1964.[79] The British Minister of Aviation J. Amery triumphantly commented: "Technically the launching was a success and trial's objectives were achieved [...] We have thus confirmed that Britain and Australia can meet their obligations under the first ELDO programme". However, he also made a comment on the continuing British participation in ELDO, which shows how Britain's initial Europeanistic enthusiasm had cooled down, possibly because of the French changed attitude towards the UK's entry in the EEC: "With the successful launching of *Blue Streak* and our experience already acquired of *Black Knight*, we are well on the way to having a national [heavy satellite launching] capability, if we choose to develop it, but it may be that for financial and other reasons there is some advantage in continuing on the basis of ELDO".[80]

If the British lagged some two years behind the original schedule on *Blue Streak*, the work on the French second stage proceeded even more slowly. By the end of 1963, when *F1* arrived at Woomera, only some 20 static trials of *Coralie*'s separate engines had been made on the LRBA's test bench at Vernon, near Paris. All of them had proved satisfactory, but the French engineers still had to test how the four motors worked together. Therefore, the first envisaged live firing of *Coralie* was re-scheduled, all being well, for the first part of 1965, and was to be followed, hopefully during the same year, by two or three launchings with a dummy third stage and a satellite payload designed with the same aerodynamic configuration foreseen for the complete launcher.[81]

West Germany, at the start of the 1960s, did not have, of course, any military medium or long-range ballistic missile or space programme and, therefore, it had to begin its space adventure practically from scratch. Its entry into the space arena was perceived as an important means of securing its technological future, which was felt to be closely intertwined with scientific and technical achievements in space. Up to 1961, i.e. during the launch phase of ESRO and ELDO, West Germany had no governmental Agency which could organize and control space

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[79] But even here things did not really go smoothly, since *Blue Streak*'s thrust was terminated after 147 seconds, i.e. six seconds earlier than intended. As a result its maximum velocity was somewhat lower than planned and its point of impact was about 625 miles from the launching site instead of the expected 950 miles. It was finally discovered that the premature engine's cut-off occurred because the vehicle developed lateral oscillations which were sufficient to deprive the engines of fuel six seconds earlier than expected. *The Times*, 28 July 1964.

[80] *The Times*, 6 June 1964.

[81] See note 2. While *Véronique* burned turpentine with nitric acid as oxidising agent, the fuel of *Coralie* (and of its test vehicle *Cora*) was UDMH with nitrogen tetroxide as oxidiser; its pressurization was achieved, as in *Véronique*, by vapourizing water with the hot combustion gases. *Coralie* was six feet in diameter, 22 feet long, weighed 11 tons, and developed a thrust of 28,000 kg from four nozzles burning for 100 seconds.

efforts of its national industry. Therefore the German government was obliged to found a non-profit corporation, GfW (*Gesellschaft für Weltraumforschung*), in order to supervise and administer its participation in ESRO and ELDO on behalf of the Ministry of Atomic Energy, to which responsibility for the promotion of space research was first assigned. During the same year a new German aerospace consortium, ASAT (*Arbeitsgemeinschaft Satellitenträgersystem),* was pieced together out of ERNO *Raumfahrttechnik* and Bölkow *Entwicklungen* KG, which began functioning in 1961 in order to start work on the third stage of *Europa 1*.

By the end of 1962 responsibility for space research passed to the newly founded Ministry of Scientific Research. The Space Research Department (SRD) of the new ministry started to perform a function similar, although on a much smaller scale, to that of NASA. Germany's effort in space, however, was more concentrated and not diversified, as in the USA, "among Army, Navy, Air Force and a civilian agency", one German industrialist commented.[82] According to the Director of the SRD, Max Mayer, Germany's "contributions to ELDO and ESRO cannot be effective without a national programme in similar fields [...] We do not want to make purely financial contributions, but rather to contribute technically. [...] What matters in our opinion is to activate German science and technology through effective co-operation in space research in such a way that no one can later say that Germany has been eclipsed by other countries in relevant fields".[83]

Thus, early in 1963 German SRD, in parallel with its engagement in ESRO and ELDO, started to develop its plans for a national space programme which included the construction of test facilities, recoverable sounding rockets, a space transporter, a multipurpose satellite, and a high-energy third stage for an eventual second generation ELDO launcher.[84]

However, Germany's work on *Europa 1*'s third stage started to lag behind, not only because of the structural unpreparedness of German space industry but also because the German stage was more complicated, in some respects, than the other two stages, since it had the task of

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82 Hochmuth (1974), p. 72; Wetmore (1963), p. 71.

83 Wetmore (1963), pp. 67 and 77.

84 The recoverable sounding rocket, designed by Dornier's System Division, employed liquid propellants and was planned to carry an 11 lb payload up to a height of 330,000 ft. The space transporter was designed by Bölkow. It was a winged, recoverable aerospace station, intended for the logistic support of space stations, a project which testified to West Germany's intention to enter in technologically advanced projects. The multi-purpose satellite, designed by Bölkow and DLV (Experimental Aerospace Institute), weighed approximately 300 lb and was intended for both scientific research and commercial applications (e.g. telecommunications). For the high-energy third stage, designed by Bölkow, different possible propellant combinations were considered: liquid hydrogen/liquid oxygen and liquid hydrogen/liquid fluorine. *Ibid.*

injecting the payload into orbit at the end of its boost phase. By December 1963, when the first complete *Blue Streak* reached Woomera, German engineers had built only a structural dummy of the third stage, and the main motor had run successfully in a number of static firings, but its final design was still to be tested. Also the two vernier motors had run several times, but development work was still in progress. Vibration tests of the third stage with a dummy engine and simulated propellants were planned to start early in 1964 in the Hawker-Siddeley's facility at Hatfield.[85]

Italy was to develop the Satellite Test Vehicle (STV), based on a design of a new type, with a variety of sensors aimed at studying the performance of its injection into orbit and the characteristics of its orbital motion. Moreover, it had to study the environmental conditions during the launch phase and its subsequent dynamical behaviour, data which were considered of the utmost importance for any future user of *Europa 1*. The Italian STV also allowed for a number of important experiments related to satellite technology, such as satellite tracking, command transmission from ground, tape recording and playback of measurements in orbit. A number of Italian firms were contributing to its development: FIAT (firings), AERFER (structure and separation system), Montecatini (pulse code modulation telemetry) and Selenia (check-out and telemetry equipment). Also the development of the Italian STV, however, suffered time slippages, because of the novelty of the task and the initial unpreparedness of Italian industries in space activities, and its completion was finally re-scheduled to the end of 1965.[86]

Belgium's task in the IP was the construction of the down range guidance station, which was to provide guidance, tracking and control of the third stage by accurate angular and distance measurements with a radio interferometry system.[87] The development of the guidance station,

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[85] A test facility was established at Ottobrunn, near Munich. There, a high-vacuum chamber was developed, which was large enough to accommodate the full-scale third stage and was expected to be operational by the end of 1964. Engine and vacuum texts were conducted by Bölkow at the State facilities of Lampoldshausen and Ottobrunn. Initially Bölkow wanted to build the motor of the third stage using high-energy criogenic propellants. However, due to the technological uncertainties still surrounding the use of these fuels, it was decided to develop a conventional propellant motor with a 2.000 kg thrust. The two smaller vernier motors with a 40 kg thrust each, and the titanium structure were developed after original design concepts comparable to the most advanced USA technology. Wetmore (1963); Stubbs (1963), pp. 307-308; *Aviation Week and Space Technology* (16 December 1963), 73-78; ELDO (1966), p. 51.

[86] ELDO (1966), p. 53.

[87] The first two stages were controlled by an autopilot which received its information from a stored programme of the attitude directions necessary to achieve the prescribed nominal trajectory. This programme was to be developed by the Van der Heem firm and tested by the National Aero and Space Laboratory, in the Netherlands. They might also employ a simplified guidance system from

built at Gove Peninsula, Northern Australia, 1200 miles down-range from the Woomera launching site, had been assigned to the three main electronic companies, ACE (*Ateliers des Constructions Electriques de Charleroy*), Bell Telephone Manufacturing Company, and MBLME (*Manufacture Belge des Lampes et de Matériel Electrique*). By the end of 1965 the station was still under construction because of slippages in the original schedule.[88]

Finally, the Netherlands had to develop an advanced design telemetry system, aimed at following the performance of the third stage and receiving telemetered signals from the satellite. This system, as well as the vehicle borne telemetry and the telemetry station for Woomera, were developed by the Dutch firm Philips. An independent telemetry station, to be installed at Gove by the end of 1965, was also a Philips development.[89]

From the outline previously given, it appears that all member states lagged well behind the schedule initially foreseen for the realization of the IP. At the beginning of this section we shed light on some of the main reasons for this delay. A last one, and certainly not the least, should be added: the two-year delay in the ratification of the Convention, which according to the British Estimates Committee, was "the biggest single factor in upsetting the initial programme".[90]

7. The ratification of the Convention and the full entry into force of ELDO

The full machinery of ELDO could not begin to work until three years after the Strasbourg conference and two years after the signature of the convention, which entered into force on 29 February 1964 when five countries (Australia, France, Great Britain, the Netherlands and West Germany) had ratified it. Belgium ratified the convention on 2 April 1964, while Italy did not ratify it until 4 March 1965, a sign of lasting Italian perplexities to join the Organization officially.[91]

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the ground which, in response to information fed back from the rocket, could correct its trajectory. *Ibid.*, p. 55.

88 *Ibid.*, pp. 55-56.

89 *Ibid.*, p. 56.

90 Estimates Committee (1966), p. IX.

91 In order to guarantee the "continuity of the collaboration" under the same conditions as in the PG interim phase, a temporary agreement between ELDO and the Italian government was approved by the Council in its first meeting. ELDO/PG(64)Secr. 51, rev. 2 and corrigendum; ELDO Council, 1st session, note 74, Annex III, 22/6/64.

The ELDO Council met for the first time on 5-6 May 1964 and was immediately obliged to face the necessity of a complete re-appraisal of the situation. In his opening address, the French minister of state in charge of scientific research and of atomic and space problems, G. Palewsky, neatly listed the problems — budgetary, technical and commercial — which the organization was to confront urgently, problems aggravated by "a period of general budgetary scarcity, as is the present case for Europe", where Governments "must often solve economical and social problems of primary urgence" and, therefore, interrogate themselves on "the priorities to be established".[92]

According to Palewsky the numerous questions to be answered regarded: a) the urgent necessity of identifying a market for the IP launcher; b) the definition of a long-term programme, by clarifying whether simply "a modification" of the initial launcher would be sufficient, or whether it should be necessary to think of "a more radical transformation", by changing "the nature of the stages" in order to develop a telecommunication satellite launcher; and, finally, whether a new equatorial launching site was needed in order to increase the useful payloads.[93]

A similar sense of haste in the solution of ELDO's thorny problems also emerged in the introductory report of the President of the PG, Havilland. ELDO's task, he maintained, was not only technically complicated by its very nature; it was further complicated by the way in which work had been distributed among member states according to the convention and by the Secretariat's lack of real powers. The total of expenditure for the first three years had increased to 151.7 M.M.U., out of a total ceiling of 196 M.M.U. initially foreseen for the completion of the IP. "The essential interest of all member countries", he warned, "demands that every effort should be made in order to avoid other delays, since this would not only imply an increase of total expenses, but, much more seriously, it would make impossible for ELDO to have a launcher within the time limit needed for its commercial exploitation.[...] If we want the ELDO launcher to be used in the frame of a world telecommunication satellite system, the performances of *Europa 1* should be improved, which would be out of question if the Initial Programme accumulate further delays". However, in its conclusion, Havilland suggested to the Council to defer every "necessary decision" on the re-appraisal of the IP budget, the commercialization of launchers and ELDO future programmes, to an intergovernmental conference to be held by the end of 1964.[94]

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92 ELDO Council, 1st session, note 74, p. 3.

93 *Ibid.*, p. 4.

94 *Ibid.*, pp. 10-15.

Therefore the Council, while postponing the discussion of these problems to the future conference of plenipotentiaries, limited its initiative to approval of a provisory agreement with Australia regarding the firings of the first phase of the IP.[95] It then proceeded with the election of the Secretary General (R. Carrobio di Carrobio), the Technical Director (W.H. Stephens), the Administrative Director (H.L. Costa), the President of the Council (G. Bock, West Germany) and its vice-presidents (A. Brown, Australia, and A. Paternotte de la Vallée, Belgium), and ratified the institution of the Finance Committee (FC) and of the Scientific and Technical Committee (STC).[96]

En attendant Godot, i.e. the conference of plenipotentiaries, the sense of urgency which characterized the first session of the Council also surfaced in the following sessions coupled, however, with decisional paralysis and political impotence. The main issues at stake were the delay accumulated in the development of the IP and the parallel increase of its budget which had risen beyond any control.

As to a reliable evaluation of the total cost for the completion of the IP, during the second session of the Council the Administrative Director Costa was obliged to admit that, because of the lack of up-dated information by member states, it had been impossible even to revise the estimate of the 1964 budget. Then Secretary General Carrobio, in the wishful thinking to reduce the delay accumulated in previous years on the IP, asked the delegates to give an evaluation of additional costs in the hypothesis of a conclusion of the IP six months in advance of the deadline scheduled in the last objective plan by the PG. But the British delegate informed his colleagues that after the adoption of the last objective plan, Great Britain had been forced to dismiss more than 100 technical staff, and that therefore it was impossible to realize the acceleration hoped for by Carrobio "without important supplementary expenses". The French delegate then curbed any residual enthusiasm by declaring that he considered it simply "a waste of time" to study the financial consequences of this acceleration "only in some sectors", since both the PG and the TC had already concluded that it was technically impossible to reduce the delay accumulated in other sectors. Therefore the Council, in its conclusions, limited itself to acknowledge the importance that member states present "a precise evaluation" of the total cost of their share of work on the IP by 1 September 1964, and expressed its wish that the inter-

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[95] *Ibid.*, annex V; see also ELDO/PG(64) Secr. 70, 14/4/64.

[96] ELDO Council, 1st session, note 74, pp. 7-8 and 21-22. See also ELDO's *Communiqué de Presse*, 6/5/64.

governmental conference should be held, at the latest, in the second half of December 1964, needing at least two months of preparation.[97]

The third session of the Council began on 20 October, the same day of the second firing of *Blue Streak*, F2, which was a complete success.[98] But this good news did not help to resolve the substantial paralysis of the Council, or smoothen the controversies on the budget. Firstly the Administrative Director informed the Council that the recruitment of the Overall Team Leader and his assistants, whose task it was to supervise ELDO operations in Australia, could not take place because of lack of co-operation by national delegations which did not send in time the list of possible candidates.[99]

The second element of friction regarded the payment of additional credits over the 1964 budget asked by Great Britain, West Germany and the Secretariat, already approved by the FC and by the STC. These requests initially met with strong opposition from the French delegate, who was contrary in principle to the concession of supplementary credits until the approval by the intergovernmental conference, according to Article 5 of the Financial Protocol, of the new budget for the completion of the IP over the original ceiling of £70 million (196 M.M.U.). Only after the British and the German delegate stressed that if their supplementary expenses were not

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97 ELDO Council, 2nd session (9-10/7/64), ELDO/C(64) PV/2, 29/7/64, pp 5-8. Two last examples can be given in order to clarify how difficult the start of ELDO was even after the entry into force of the convention. The first refers to the persisting lack of real powers by the Secretariat: in fact, the *ad hoc* group charged by the PG to define ELDO rules on contracts suggested in its report that "in case of doubt or disagreement" the Secretariat should be given a "decisional role" in order to resolve "questions of compatibility between works of different member States" (ELDO/PG/A/59 rev. 7 Corrig., Art. 12b). However, the Council finally preferred a text where the phrasing "decisional role" was changed to "role of persuasion" by the Secretariat; ELDO Council, 2nd session, p. 19. The second example regards the lasting difficulties in the management of work and the recruitment of technical staff, which according to the Technical Director, was still "unfortunately slow and difficult". Council delegations, acknowledging the importance of organizing "urgently" the work in Australia, authorized the Secretariat to send a member of the Secretariat in Australia in its quality of "Overall Team Leader" and to proceed with the recruitment of staff to overview the operations there, but at the same time, expressed the hope of avoiding an undue "swelling" of staff and suggested the Secretariat "to use at most the services existing there"; *ibid.*, pp. 24-26.

98 The UK delegate reported that the engine worked for 150 sec., the rocket covered a distance of 860 nautical miles, 10 miles more than foreseen, reaching an apogee of 123 nautical miles, 4 nautical miles below the expected height. Telemetry instruments followed its flight for 9 and a half minutes, and there was good visual tracking for 5 minutes. This time the vehicle showed no instability. ELDO Council, 3rd session (20-21/10/64), ELDO/C(64) PV/3, 27/11/64, p. 1.

99 ELDO Council, 3rd session, note 98, p. 3.

paid they would be forced to slow down or even suspend the work on the IP, the French eventually accepted a compromise solution.[100]

A third element of concern was the 1965 budget. The President of the FC informed the Council that, because of the delay by member states in presenting their budget estimates for 1965, it could not be ready before 31 December and could not be discussed by the Council before the end of January or, more probably, in February 1965. Therefore, he suggested that provisory measures should be adopted for the first two months of 1965 due to the increase of expenses; but his proposal again met the strong opposition of the French delegate who refused to vote in favour of supplementary credits regarding both the work already in hand on the IP and studies on future programmes before the intergovernmental conference had taken a definite decision.[101]

No wonder, then that, against all these problems far from being resolved, the Council decided again to defer the discussion on budgetary questions to a next session, to be held early in December and to be entirely devoted to the preparation of the conference of plenipotentiaries, postponed in turn to mid-January1965.[102]

However, also the fourth session of the Council, held on 7-10 December, did not proceed smoothly notwithstanding the strenuous efforts made by the Secretariat and by the FC and the STC to reach a definite conclusion on some of the issues at stake, in particular on the budget

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[100]The additional appropriations requested by the UK's Hawker Siddeley Dynamics were due in part (about 800,000 M.U.) to economic factors like wage increases due to inflation, etc., in part (about 440,000 M.U.) to technical factors resulting in particular from the F1 firing; an additional 112,000 M.U. had been requested by the UK for "transport fees of passengers and freight" to Australia and had been approved definitely by the FC as they could be covered by real savings. The sum requested by West Germany, for a total of 213,000 M.U., regarded the construction of telemetry antennas and for investment at Trauen, due to increase in construction costs and modifications of a test stand. The credits requested by the Secretariat, for a total of 639,500 M.U., were due to the increase of personnel costs, the hiring of additional personnel and the payment of sub-contracted parts for the engines; *ibid.* pp. 6-9. The delegate of the Netherlands then informed the Council that in the very near future his delegation would also present a request for a supplementary budget for 1964, and if the Council did not approve it his country would also be forced to stop work on the IP. Finally, the Australian delegate informed the Council that in compiling the Australian 1965 budget a revision was made of the 1964 estimates, according to which further 800,000 M.U. for 1964 were due to his country for operational costs. The compromise solution finally approved by the Council covered only in part the requests of West Germany and the UK for a total of 1,235,500 M.U.; *ibid.*, pp. 9-12. See also *Résumé de Conclusions*, ELDO/Sec(64) 52, 23/10/62.

[101]ELDO Council, 3rd session, note 98, pp. 13-14.

[102]*Ibid.*, p. 33.

and the new cost estimate for the completion of the IP, which had paralysed the work of the Council in its previous sessions.

First, the Chairman of the FC Goodson presented the revised cost estimate of the IP, which had been discussed by both the FC and the STC at a joint meeting held on 23 and 25 November. But he explained that what he presented was a "simple summation" of the estimates submitted by member states, since the information available was "inadequate" for them to establish the validity of the cost estimates presented; in particular, he maintained, the Secretariat had been "hampered" in its task by "member States' interpretation of their leadership responsibilities", a euphemism to stress once again the persisting lack of control power by the Secretariat.[103]

The new basic cost estimate proposed by the Secretariat to be approved by the conference of plenipotentiaries amounted to 329 MMU, at prices ruling April 1964, which included provision for firings of live third stage and experiments on Satellite Test Vehicle from the French base of Coulomb Béchar in Algeria, and the re-instatement of the F10, whose deletion had been suggested by the PG in the last objective plan in an effort to keep the expenses within the Lancaster House ceiling. But the Secretariat itself suggested that a contingency of at least 40% of the amount still to be spent should be added, thus bringing the total cost of the IP up to its completion to about 400 M.M.U., i.e. more than twice the original Lancaster House ceiling of 196 M.M.U.[104]

Once again, various delegates expressed "profound concern" about the "imprecisions" in these estimates. The Belgian delegate, in particular, suggested that all member states should be required to present more accurate and detailed development plans and cost estimates on the IP before the intergovernmental conference. Other discussions among national delegations took place on the high level of the foreseen contingency, and on the fact that it was not clear if it covered only technical difficulties which could not be foreseen, or also provided for changes in economic circumstances. Finally the Council accepted the figure of 339 MMU, with the pro-

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[103]ELDO Council, 4th session (7-8-9/12/64), ELDO/C(64) PV/4, 13/1/65, p. 3.

[104]This figure included: a) the cost of the IP to F9 (292 M.M.U., as estimated by member States); b) administrative costs (14 M.M.U., as estimated by the Secretariat); c) additional work, (8 M.M.U., as estimated by the Secretariat); d) the re-instatement of F10 (15 M.M.U., as estimated by the Secretariat), *ibid.* pp. 3-4. According to the chairman of the STC the deletion of F10 had always been "undesirable technically"; therefore, its re-instatement was now proposed by the Secretariat and supported by the STC. The huge amount of the contingency to be included had given "great concern" to both the FC and the STC, as reported in quoted Resolutions ELDO/T(64)10 and ELDO/F(64)22. In particular, the Resolution of the FC had been subject to reserves by the delegates of Belgium, France, Italy and the Netherlands concerning the restrictions which should be placed upon the use of the contingency.

posed 40% contingency for "technical" factors, as the basic cost estimate to be submitted to the conference of plenipotentiaries with a statement of the views expressed by the various delegations, and agreed that the conference should define the "main principles" within which the contingency should be used and accordingly instruct the Council to prepare a suitable scheme.[105]

8. First debates on future programmes

The dilatory attitude of the ELDO Council and its structural incapability of exercising in full its decisional role are testified by the way in which it handled another burning issue, i.e. the definition of further programmes of the Organization.

In July 1964, during its second session, the Council limited itself to take note of a preliminary report on future programmes presented by the Secretariat, whose underlying philosophy was simply that any improvement in the performance of future launchers should be realized through "successive steps" starting from *Europa 1*, as the most economic and rapid procedure.

On that occasion the Technical Director, Stephens, stressed the importance of linking ELDO decisions on future developments to those of CETS, while the British delegate maintained that "continuity of work" between the IP and ELDO future programmes was considered "essential" by the UK and asked that important elements like the costs and schedule of future programmes should be defined before the end of 1964 in time to be discussed by the intergovernmental conference.

The Secretary General, on his part, declared his "readiness" to play the role of the Preparatory Group for the organization of the intergovernmental conference, by preparing a report, to be ready hopefully by mid-September, on the financial aspects of future programmes, the scale of contributions to be adopted, the methods to be used for the division of tasks and the commercialization of vectors. But the Council, while establishing that the principal aim of the conference was to examine and revise the estimates of expenditure on the IP, limited itself to judge "reasonable that it equally study the perspectives for the next five years".[106]

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[105] ELDO Council, 4th session, note 103, pp. 6-9. The 40% contingency did include, however, as the Technical Director explained, provision for major accidents or catastrophes such as the distruction of the launching pad or the complete failure of a firing. See also *The estimated cost to completion of the ELDO Initial Programme*, Note by the Secretariat, ELDO/CG (Jan 65) 3, 18/12/64.

[106] ELDO Council, 2nd session (9-10/7/64) , ELDO/C(64) PV/2, 29/7/64, pp. 2-6.

The Council did not start to discuss the proposals on the future programmes until October 1964, during its third session, where the Chairman of the STC presented a report of the conclusions reached by the Committee at its first meeting held in Paris on 29 September.[107] The purpose of his report was to present the "general principles" which should govern the policy for the further work of ELDO, and to give a broad outline of the corresponding programmes with an "approximate indication" of the associated timescale. The underlying hope, soon to reveal itself totally unrealistic, was that development work on future programmes could start early in 1965. The general principles suggested, rather vague in their apparent generality, were the "need for broadening the basis of European space vehicle development activity", the "technical continuity" in the programmes to be undertaken, and an "efficient technical management", which, however, was still to rely, as for the IP, on outside capabilities of national firms and establishments. Also the aims, in terms of future missions, were hazy: ELDO was to meet as yet unspecified ESRO's technical requirements on LAS, and was to be capable "rapidly and economically" of placing into orbit telecommunication satellites, with payloads for operational networks meeting the still to be defined requirements of telecommunication authorities, "whatever type of system was finally adopted".[108]

In order to achieve these aims, ELDO would have to develop, within 1968-69, the so called *ELDO A/S* launcher, which was based on *Europa 1* with an extra apogee stage[109], and by 1970-71 it should realize a more powerful launcher, *ELDO B*, which was to be based on *Blue Streak* as the first stage and one or two high-energy upper stages using liquid oxygen and liquid hydrogen as propellants.[110]

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[107] *Report by the Chairman of the Scientific and Technical Comittee to the ELDO Council on the Future Programmes of the Organization*, ELDO Council, 3rd session (20-21/10/64), ELDO/C(64) PV/3, 27/11/64, Annex 1. See also ELDO/T(64) PV/1, 29/9/64.

[108] *Ibid.*

[109] The PG authorized, as provided for in Article 16(3) of the convention, two parallel project studies on the apogee rocket system, attributed in December 1963 to the French SEREB and the British Royal Aircraft Establishment respectively, for an expense of 100,000 M.U. each. The proposals for these studies were set out in ELDO/PG(64)T/5, 16/4/64, and approval was given by the PG's Technical Committee on 24 April 1964; ELDO Preparatory Group, TC meeting (24/4/64), ELDO/PG(64) T/PV/2, 27/5/64. These studies, which concerned a definition of the whole launcher system with its apogee stage and also a feasibility study of the experimental payload, were to be completed in time for development work to get under way in the first quarter of 1965. See also ELDO Council, 3rd session, note 107, pp. 24-25, and Annex 1, p. 35.

[110] Preliminary studies on *ELDO B* had been already carried out in different member states. Their conclusions, as confirmed at a meeting of experts held on 23 September 1964, were that it would be "desirable" to use liquid oxigen/liquid hydrogen as propellant, and the basic propulsion unit should have a thrust of 5 to 7 tons. However, widely different proposals were put forward concerning the mass distribution of the different stages of *ELDO B*, so that the Secretariat could not assess "with

But even before these proposals were discussed, conflicting opinions surfaced among national delegations on the criteria to be adopted for the division of work on future programmes. In fact, Article 6(3) of the convention established that the Council had the task of determining "the adequate distribution of the work on the further programmes of the organization in the light of technical and economic criteria", but it did not give any detailed specification of these criteria. This point gave rise to Byzantine discussions among delegations. While the British delegate anticipated how the practical application of those principles would give rise to "great difficulties", the Belgian delegate, backed by the Dutch, stressed how the work on the IP was not going to be justified unless it were "expanded" in future programmes. Since the "principal hope" for commercialization of future launchers consisted in their use for telecommunication satellites, "efficiency" should be the main criterion to be adopted if ELDO wanted to arrive at a competitive position within 1970. The German delegate, on his part, advanced serious doubts about the adoption of efficiency as the main criterion for the division of work on future programmes, and stressed how the development of techniques and dissemination of information in member states, as specified by Article 2(4) of the Convention, and the training of staff were fundamental aims of the organization to which great importance should be attached. Finally the Italian delegate, striking once again the note of "just return", underlined how the financial contributions of member states were to be considered a "key factor" in the distribution of work on further programmes, since the economic benefits to be gained by member states would be a matter of great importance to them. Naturally, no common position could be reached and the Council took again a dilatory stance, by deferring the problem to its next session, to be held early in December, and asking national delegations to study "in depth" the problem in consultation with their national authorities and to send written comments to the Secretariat before 10 November 1964.[111] The main unsolved problem, however, was due to the fact that ELDO was born as an organization without users and a definite plan of missions. In fact, as the chairman of the STC pointed out on different occasions, a programme on future launchers should logically be conceived as a function of the missions to be assigned to it, but this programme could only be defined within the framework of a European space policy, which for the time being did not exist.

In the meantime, CETS had finally made explicit the operational requirements and timescale of its telecommunication satellite programme: a) flight testing of component parts and sub-systems of communication satellites from 1968 on; b) launching of experimental communication satellites of operational type in 1970-71. Therefore, on the basis of the CETS require-

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any confidence" their advantages and disadvantages. ELDO Council, 3rd session, note 107, Annex 1, p. 36.

[111] ELDO Council, 3rd session, note 107, pp. 27-29.

ments, the STC set up a Working Group in order to reach a rapid definition of the technical content, costs and timescale of future programmes.

As to the *ELDO A/S* launcher, the proposals framed by the Working Group and approved by the STC in its second meeting held on 23-24 November concerned: a) the development of an apogee stage with solid propellant motor, and the execution of sub-orbital tests using low-cost means already available; b) modifications to *Europa 1* and its associated equipment as required for optimum use of the apogee stage; c) the realization of the inertial guidance system, which was considered a necessary tool in order to insure maximum flexibility in the choice of orbits, irrespective of the launching site and type of vehicle. Three trial firings of *ELDO A/S* into polar orbits were foreseen from Woomera. A tentative timescale provided for the first orbital launching in 1968, and the completion of the programme by mid-1969; its estimated cost amounted to 50 M.M.U. spread over five years (1965-1969).[112]

The *ELDO B* programme comprised two models, a two-stage (*ELDO B1*) and a three-stage (*ELDO B2*) launcher, to be realized in two steps.

According to the conclusions of the STC the tasks to be fulfilled for the realization of *ELDO B1* included: a) the modifications of *Blue Streak* and associated ground facilities as required for optimum use of the complete launcher; b) the development of a high-energy second stage, with a motor powered by liquid hydrogen/liquid oxygen giving a maximum thrust of about six tons; c) the realization of an apogee stage, by making use of the techniques acquired in the development of *ELDO A/S*. Four test flights of the vehicle without apogee stage and one flight of the complete vehicle were foreseen. According to the suggested timescale, initial launchings were to take place before the end of 1970 and its completion was foreseen by the end of 1971 or early in 1972, at an estimated total cost of 140 M.M.U. spread over seven years.[113]

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[112] *Proposals for future activities of the Organization*, Note by the Secretariat, ELDO/C(64) 38 rev., 2/12/64. The estimated payload capability of *ELDO A/S* was of 110 kg into an 8-hour polar orbit (height of about 14,000 km) and of 170 kg into a 6-hour orbit (10,400 km). In other words, *ELDO A/S* did not have geostationary capability. The foreseen weight of telecommunication equipment, which could reach some 25% of the total orbited weight, was at most 40 kg. That is why the STC concluded that *ELDO A/S* was "suitable only for component and sub-assembly tests" of the CETS satellite.

[113] *Ibid.* The estimated performance capability of *ELDO B1*, without apogee stage, was of 1.5 to 2 tonnes in low orbit, while its performance with apogee stage could reach 500 or 600 kg respectively into a 6 or 8 hour polar orbit, by assuming easterly launching from an equatorial site.

The proposed *ELDO B2* launcher was based on a modified *Blue Streak* first stage as well, but it could reach performances much higher than those of *ELDO B1* because of its two high-energy upper stages, powered by clusters of motors of the type developed for *ELDO B1*'s second stage. Its initial launchings were foreseen by 1971 and its completion by 1972-73, provided the programme could enter into its development phase before the end of 1966. At least four flight test firings were foreseen and the estimated cost of the programme was of 100 M.M.U. spread over 7 years.[114]

The question of future ELDO programmes was discussed again by the Council during its fourth session, which took place from 7 to 9 December. Four days earlier, as the Chairman of the Council Bock announced at the opening of the session, the Assembly of Western European Union at its 10th ordinary session had passed a unanimous resolution to the WEU Council of Ministers recommending that "the Member Governments be urged to call for a programme for the inter-European bodies which already exist, and which, with due regard to their statutes, will enable them to reach the most advanced level of development as soon as possible".[115] But the exhortation of the WEU was not of great help to the Council.

The STC, in its report to the Council, while recognising that the *ELDO A/S* launcher could be "suitable only for the component and subassembly tests" of the satellite system foreseen by CETS, nevertheless considered the realization of this vector "an essential step" for the development of techniques related to the use of *ELDO B* for telecommunication purposes and for the "broadening of ELDO expertise". Therefore, the STC recommended the "simultaneous technical and cost approval" of both the *ELDO A/S* an *ELDO B* programmes, and asked that each of these programmes be put into the development phase "as soon as their respective development cost plans can be prepared and approved".[116]

As to the cost estimates of *ELDO A/S* and *ELDO B*, the Chairman of the FC, Goodson, informed the Council that the FC had no information on them, except for the "bare figures" submitted (40-50 M.M.U. for *ELDO A/S*, and 140 MMU for *ELDO B1*, including the addition of the apogee stage) with an allowance for contingencies of 40%. Therefore the FC "felt bound" to draw attention to the "approximate nature" of these estimates. The Chairman of the STC, on his

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[114] *Ibid.* The performance capability of *ELDO B2* was of 3 to 3.5 tonnes into low orbit, 1000 or 1500 kg respectively into a 6 or 8 hour polar orbit, and up to 1000 kg into a geo-stationary one. See also *Proposals for future development work of the organization*, Note by the Secretariat, ELDO/CG (Jan 65) 1 rev., 15/1/65.

[115] ELDO Council, 4th session (7-8-9/12/64), ELDO/C(64) PV/4, 13/1/65, p. 1.

[116] *Ibid.*, p. 12.

part, drew attention to the different "degree of precision" in the evaluation of those estimates. He admitted, in fact, that there was no complete development cost plan yet for *ELDO A/S*, but its estimate was "more precise" than that of *ELDO B* which, however, had been studied since the beginning of the year by expert groups in France, Germany and Britain.[117]

In the general discussion the Dutch delegate, while considering the *ELDO A/S* already in a "ripe state" for Governments to commit themselves, felt that better information on time-scale and cost was needed for *ELDO B*; the Italian delegate expressed some doubts about the estimates of *ELDO A/S* which he thought were too low, and the delegate of Australia, referring to the doubts expressed by the Chairman of the FC, suggested that there was "no foundation for absolute approval" of the two programmes. On his part, the delegate of France, backed by the German delegate, strongly defended the thesis that *ELDO A/S* and *ELDO B* should go forward together as "parts of an integrated programme", and asked the Council for a clear decision linking them. After a long debate the Council substantially approved the French thesis, concluding that both the programmes proposed represented "the most desirable orientation" for the development work of ELDO in the period 1965-1972. Moreover, the Council considered the evaluation of costs and timescale as a "realistic estimate", although made in such a way as to be "as precise as is at present possible", and expressed its wish that the conference of plenipotentiaries would give their opinion on the orientation of ELDO programmes and indicate for their funding "an order of magnitude accepted by the Governments". In the absence of a definite programme of missions and of precise commitments by potential users, the ELDO Council probably could not go further, and bet its last card on the conference of plenipotentiaries in the hope, shared by all the delegates, that it would include in its scope a definition of European space policy in space research and development, "bearing in mind" the needs of ESRO and the CETS, and coordinating the activities of these organizations with ELDO.[118]

9. Conclusion

In sum, after the long awaited ratification of the convention the full entry into force of ELDO was not at all an easy and successful process: all the problems characterizing the interim period of the PG — on budget, lack of an efficient and centralized management, time-slippages in the realization of the IP, search of clients for *Europa 1*, and choice of future programmes — were left unsolved. On the one hand, co-operation of member states with the Secretariat did not

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[117] *Ibid.*, pp. 16 and 19. Early studies on *ELDO B* were reported in ELDO/C(64) 12, 25/6/64, and ELDO/T(64) 2, 2/9/64.

[118] ELDO Council, 4th session, note 115.

improve and no real effort was made to strengthen its role. On the other, the Council, paralysed by conflicting views of national delegations on most of the issues at stake, substantially renounced to exercise its decisional role, and deferred the solution of every problem to a higher political forum, the intergovernmental conference, in expectation of a resolutory strike of its magic wand. However, its hope, as we shall see in a subsequent paper, was soon to be disappointed. Finally, it should be stressed that the postponement by the Council of any critical issue to the highest possible level and its concomitant political self-emptying was to become a permanent feature of ELDO, which contributed to enhancing its inefficiency and to bringing about its final failure.

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