Space for ambitions

the Dutch space program in changing European and transatlantic contexts

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Abstract: Why would a small country like the Netherlands become active in space? The field was monopolized by large countries with large military establishments, especially in the early years of spaceflight. Nevertheless, the Netherlands established a space program in the late 1960s. In this paper I will analyze the backgrounds of Dutch space policy in international post-war politics, national industrial policy, and science. After the Second World War, European space activities were shaped by the interplay between transatlantic and European cooperation and competition, limited by American Cold War diplomacy. At the national level the Dutch space program was shaped firstly by two powerful companies, Philips electronics and Fokker Aircraft. As I will demonstrate, these two firms sought to gain crucial management skills as well as technological ones. Meanwhile, the nation's astronomers were able to capitalize on an advantageous confluence of political, economic and scientific ambitions to forward their own agenda. They succeeded in obtaining two of the most expensive scientific instruments ever built in the Netherlands: the Astronomical Netherlands Satellite (ANS, launched 1974) and the Infrared Astronomical Satellite (IRAS, 1983). Both were joint Dutch-American missions, but the nature of the cooperation on each was very different, reflecting the changing relationship between America and Western Europe from the 1950s until the 1980s.

In 1965, the Dutch astronomical community received a letter from the Ministry of Education and Sciences. The government had decided to fund the construction of a satellite; would the astronomers have any use for it? The result, launched in 1974, was the Astronomical Netherlands Satellite (ANS). Several years later, the same thing happened again. Almost without having to ask, the astronomers were provided with two of the most expensive scientific instruments ever built in the Netherlands, the only 'national' Dutch satellites. To understand why, one has to analyze international politics, small country diplomacy, industrial ambitions, and a remarkably efficient scientific community.

Putting scientific instruments into space is an appealing idea for scientists, but realizing it requires an expensive infrastructure and access to strategically important technologies. Until recently, only national governments had the resources needed to sustain space programs. And even then, very few nations were able to acquire access to space on their own. Because of the possible military uses of satellites and launch vehicles (missiles), but also because of the high public visibility and prestige of space technology, spaceflight has always been shaped by international relations. During the Cold War, both the United States and the Soviet Union exploited space for strategic and diplomatic aims (MacDougall 1986; Logsdon 1996; Krige 2006b).

In Western Europe, the Cold War was not the most important political context for spaceflight, however. Effectively shut out of direct competition with the superpowers, European countries focused on inter-European cooperation and competition, sometimes pooling resources to attempt to catch up with America. The two superpowers (or rather one: America) defined the framework in which European nations could operate, but within those boundaries national and regional politics shaped European space programs. Economic competition and political power struggles within the Western world were more urgent concerns than a direct confrontation with the Eastern bloc.[1]

In recent years, American-European relations in science during the early Cold War have received much attention, especially since John Krige's seminal *American Hegemony* (Krige 2006a). Krige showed how European science was rebuilt according to American values in the immediate postwar period. This paper focuses on a later period, when European scientific and industrial infrastructures were fully (re)established and Western European nations were firmly integrated in the Western bloc. America remained a major force in Europe, however, especially in defense issues but also in its continued support for European science and technology programs. The superpower was still a hegemon, although the nature of its relationship to Europe changed, as this paper will show.

The main perspective of this paper is that of a small country: the Netherlands. The Dutch space program has not been studied in depth before.[2] The Dutch case is particularly interesting because it enables us to study the dynamics between the Atlantic and European arenas from the 1950s until the 1980s. After introducing the international and national backgrounds of the Dutch space effort, I will describe in some detail two satellite projects that illustrate the interplay between domestic, regional and global contexts: ANS, conceived in 1965 and launched in 1974, and its successor, the Infrared Astronomical Satellite (IRAS, 1974-1983). Both satellites were joint Dutch-American projects, and IRAS also included Great Britain in a supporting role.

ANS and IRAS were two big science projects in a small country. While foreign policy provided a major stimulus for the government to support a national space program, other motivations have to be understood as well. Two powerful companies, Philips Electronics and Fokker Aircraft, played a crucial role in Dutch economic and industrial policy. For these companies space was as much about

[1] An excellent overview of the literature about European space programs is provided by Zellmayer 2008 23-30.
[2] Van Kasteren 2002 compiled a brief overview in the context of the ESA history project; De Kort 2003 provides a more extensive history.

management skills as technological prowess. The fact that both satellites were astronomical instruments illustrates the special status of the astronomical community in the Netherlands.

Scientific, economic and diplomatic aims coincided to create a Dutch space program in the 1960s and 1970s, and policy makers sought to take advantage of the global political situation for their own ends. This three-way confluence of ambitions ended in the 1980s, making a third astronomical satellite politically impossible. That will be the end point of this paper.

Setting the Stage: space diplomacy

Space research first caught the attention of the public, including most scientists, with the launch of Sputnik in October 1957. Both Sputnik and its American counterpart, Explorer, were launched during the International Geophysical Year. Scientific research was thus the first application of space satellites, but it was not the primary motivation for their creation. From the very beginning, national security, reconnaissance, prestige and Cold War propaganda were central to the space programs of both the United States and the Soviet Union (MacDougall 1986). All launch technology was military technology, developed primarily for ballistic missiles (DeVorkin 1992).

Soon after Sputnik, two international organizations were set up to mitigate the political consequences of the Space Race: the United Nations Committee on the Peaceful Uses of Outer Space and the scientific Committee for Space Research (COSPAR). The latter was intended to stimulate international cooperation and to ensure that space research became a civilian instead of a military undertaking (Greenaway 1996; Haerendel 1998). The first meeting of COSPAR in November 1958 was attended by scientists from the seven countries that had an active space program at the time. Lacking a space program, no Dutch representative was invited, but astronomer Jan Oort was invited to represent the International Astronomical Union, of which he was president. Oort did not attend the meeting himself but sent his protégé Henk van de Hulst (De Kort 2003 28). The two astronomers had previously cooperated on radio astronomy. Van de Hulst traveled to London and was elected first president of COSPAR, thereby reinforcing the longstanding tradition of active Dutch involvement in international organizations, especially in astronomy (DeVorkin 2000; Baneke 2010).

At the second meeting of COSPAR, the American representative, Richard M. Porter, announced an American offer to launch foreign scientific instruments free of charge. This offer was underwritten by the newly founded National Aeronautics and Space Administration (NASA). One of the objectives of American space activities, as specified in the Space Act of 1958, was to engage in peaceful international cooperation and to "make every effort to enlist the support and cooperation of appropriate scientists and engineers of other countries and international organizations."[3] The

[3] http://www.nasa.gov/offices/ogc/about/space_act1.html.

launch offer is a textbook example of the role of science and technology in American foreign policy throughout the Cold War (Krige 2006a,b). It used American technological leadership to project the image of the nation as a benign hegemon on the international stage. The military nature of rocketry was downplayed by offering it to the international scientific community for peaceful use.

NASA’s international program was created with other international efforts in mind. These included the International Geophysical Year and the United States’ Atoms for Peace program. In fact, in 1959 NASA hired Arnold Frutkin, who had been involved in the IGY, to create its international program. He established the guidelines for international cooperation in space. To prevent any suspicion of American interference in the internal affairs of foreign nations (and domestic charges of wasting money), he insisted that there should be no exchange of funds between countries. For the same reason, he preferred projects that were initiated by the foreign partner. Other guidelines required that in order to gain NASA’s support, the projects should be scientifically valid and have a well-defined goal and a clear end date. The resulting data was to be made available to all scientists (Frutkin 1965; Sebesta 1994a).

NASA’s dealings with foreign agencies were always carefully coordinated with the State Department. Frutkin was explicit about the aims of international cooperation: creating goodwill, enhancing America’s technical leadership, and mobilizing other countries’ resources for space technology and science. He expected the United States to benefit from foreign space programs, both directly through contracts for American industry (a significant percentage of foreign space budgets was spent in the US) and indirectly because its lead put America in a good position to profit from new developments in science and technology (cf. Krige 2010). Frutkin emphatically denied that America wanted to encourage foreign space science in order to divert funding from military space projects, but it is clear that this argument did play an important role in NASA’s later foreign policy (Sebesta 1994b).

The launch offer made it possible for new countries to embark on serious space science programs. At the time, in Europe, only France had a domestic rocket program with satellite launching capabilities. Britain had decided to convert its Blue Streak missile development project into a civilian European program, in part because its military value was doubted and in part because developing it further would be too expensive. This move was approved by America, which had provided technical support for the missile (Krige and Russo 2000 81-87). The British-American Ariel 1 (1962) was the first international satellite to be launched by the Americans; the Italian San Marco I (1964) was the first European-built satellite. Many others followed, initially mainly from Canada and

Western Europe. An American diplomat remarked in 1963, "It seems to me that we are giving away an awful lot free – and I wonder a bit if the Europeans won't expect the moon".[4]

Dutch in Space

No Dutch space programs existed before 1960. The launch of Sputnik seemed to mark the turning point in national space policy, yet as in many European countries, it was the international developments after Sputnik that changed the policy landscape in fact.

The first signs of government interest in space came from Joseph Luns, the minister of Foreign Affairs (and future Secretary General of NATO), in August 1959. In preparation for a meeting of the United Nations space committee, he asked the Royal Netherlands Academy of Sciences for suggestions regarding space activities. Luns' letter ended up on the desk of the astronomers Oort and Van de Hulst, who suggested contributing to international space activities through scientific research or through administrative activities. They listed the oft-repeated arguments about the favorable position of the Dutch on the international stage: they had excellent reputations as scientists, diplomats and polyglots, and being from a small country they did not affect the international balance of power.[5] A few months later, Luns warned his fellow ministers that NASA had found no relevant Dutch institution to talk to about collaboration in space. For political, scientific, technological and commercial reasons, the Netherlands should not allow itself to be left behind, he wrote.[6]

In the meantime, two physicists who had been involved in the founding of the European Organization for Nuclear Research (CERN), Eduardo Amaldi and Pierre Auger, had launched a plan for similar cooperation in space research (Krige and Russo 2000). At that time, Western European countries had just started several international cooperations, including the European Economic Community and CERN. The Netherlands had joined these organizations. It tended to support strong international organizations, in which smaller countries were guaranteed to have a voice, minimizing room for power play by large nations. Joining a European space organization therefore seemed natural to the Dutch government. Oort and Van de Hulst also supported the 'Amaldi plan', preferring a civilian, European structure instead of coordination by NATO (the 'Seitz plan'), which was a serious alternative at the time.[7]

Luns wanted to join the negotiations 'both because of the countries that will join this European organization, and for financial, personal and scientific reasons.' He hoped that the new organization would cooperate with the United States in order to benefit from America's technological prowess.

[4] Letter from Edgar L. Piret, US embassy in Paris, 19-12-1963, NACP, RC59: State Department records, file SP11.
[5] Oort to Koksma, 18-8-1959, GROC 347-16.
[6] Letter from Luns, 23-1-1960, NATH, Algemene Zaken records, file 5714.
[7] NATH, Algemene Zaken records, file 7509; GROC 347-16.

Significantly, Britain, which had not joined the European Economic Community, would probably join the new European space organization. The Netherlands always strongly encouraged Britain's involvement in European projects to counterbalance the large continental nations, particularly France but also Germany (Voorhoeve 1979; Hellema 2009). But Luns also wanted the Dutch opinion to carry weight in the negotiations. The best way to ensure that, according to the astronomers, would be to have a 'modest but sophisticated' (*bescheiden maar weloverwogen*) domestic space program. A 'modest' program was expected to be sufficient because of the nation's experience in international organizations, its strong astronomical community, and its prominent national electronics and aircraft industries.[8]

Being a small country that 'punched above its weight' on the international stage was a standard trope in Dutch cultural nationalism since the end of the nineteenth century. The nation was proud of the traditionally prominent role of Dutch officials in international organizations (scientific and otherwise) (Voorhoeve 1979; Somsen 2008). This was considered to be typically Dutch even though similar traditions existed for example in Belgium, Switzerland or the Scandinavian countries. The role of disinterested mediator was a common way for a small country to present itself on the international stage (Somsen 2008). Despite the Netherland's NATO membership, some scientists even referred to the nation's 'neutrality' during the Cold War![9] At the same time, the Netherlands always feared falling behind Europe's leading large nations. Especially the loss of Indonesia as a colony in the 1940s stirred fears of being reduced to 'the international significance of Denmark'. The – unspoken – ambition was that the Netherlands should be the smallest of the large countries rather than a relatively large small nation.

While international politics provided the main initial stimulus for the Netherlands to embark on space activities, industrial and scientific interests also played an important role. The two were closely related after the Second World War. Dutch scientists and policy makers feared that all research had ground to a halt during the German occupation, while developments in America, Britain and Germany itself had speeded up. Closing the resulting gap was a major national concern. The lack of natural resources, the presence of a highly skilled work force, and a shortage of foreign currency, made investing in labor- and knowledge intensive industries aimed at high-value exports a national priority (Baggen et.al 2010). Philips Electronics and Fokker Aircraft were two of the flagship companies in this respect, and they wielded considerable political influence. Both were the dominant (or in the case of Fokker, the only) company in their industrial sectors, the two most directly relevant to space activities.

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[8] Oort and Van de Hulst, 9-6-1960, and: Luns, 18-6-1960, GROC 347-16.
[9] Interviews by the author with Cees de Jager and Harry van der Laan.

Economic and political aims reinforced each other. The government insisted that the nation should have an independent, 'creative' (*zelfscheppende*) aircraft industry, meaning that it should be capable of designing and developing its own aircraft models (Dierikx 2004). The Netherlands Institute for Aircraft Development (NIV) was founded in 1946 to support Fokker's development projects (Muller 1997). Similar considerations applied to Philips, albeit less explicitly. While the Netherlands did not have a significant military-industrial complex (possibly excepting the naval sector), one could speak of a scientific-industrial complex in which Philips played a central role. The company was actively involved in all major national science projects after the Second World War, including nuclear research, computing and radio astronomy, and it cultivated close ties with several universities. Philips' Physics Laboratory (*Natuurkundig Laboratorium* or Nat.Lab.) was the largest employer of scientists in the Netherlands and maintained an excellent reputation (De Vries 2005). Its broad reach may have been based on an 'arsenal of knowledge' philosophy: being involved in many fields would ensure having the knowledge and flexibility to quickly react to new developments (cf Krige 2010). As Philips was one of the largest Dutch companies and by far the largest in its field, this philosophy was a national interest as well as a commercial one. It was closely related to the national policy of being involved in all the major international organizations.

Of course, joining the 'club' of spacefaring nations was a motivation in itself (cf. Paikowski 2009). For any country concerned with its international clout, being left behind in such a visible field was unthinkable. Naturally connected to the question of prestige was national security. Military involvement in space programs varied across Europe. In France, military concerns played a crucial role in space policy, for example, just as they did in polar research with sounding rockets in the Nordic countries. Sweden, with its large aerospace sector, also maintained a fairly large national space program (Lundin et.al. 2010). Britain's space activities were strongly military before it joined the European space organizations (Massey 1986). In the Netherlands, as in Germany, the military was almost completely absent from discussions about space. The defense ministry was not represented in any of the committees on space policy.

The Netherlands was not the only country for whom joining a European space organization was primarily a matter of foreign policy. Switzerland, for example, regarded it as a means to show international solidarity without breaking its policy of neutrality (Zellmayer 2008). West-Germany used space policy as an instrument in its long-standing efforts to balance French and American interests and also to embark on high-tech development projects without violating the restrictions on military technology that were imposed on it after the war. To emphasize its scientific, non-military nature, the German space program was coordinated by the country's Atomic Energy Ministry. It was not until the late 1960s that a coherent space policy emerged in Germany (Reinke 2007). Other countries had similar motivations (Collett 1995; Laureys 2008). At the same time, many European countries, including for example Spain and Finland, did not become active in space until much later.

In 1964, a European organization was finally founded – or rather, two organizations: the European Space Research Organization (ESRO) and the European Launcher Development Organization (ELDO). Until ELDO had produced a functional rocket, ESRO would make use of the American launch offer to launch its instruments. The Netherlands joined both organizations.

The Astronomical Netherlands Satellite

When diplomatic activities surrounding spaceflight started in the late 1950s, no space research was being done in the Netherlands. A small beginning was made in 1959 with the founding of a Royal Academy committee for Geophysics and Space Research (GROC) (Van Berkel 2011 328-336). The committee was to coordinate the research part of the 'modest but sophisticated' national space program, while the National Aerospace Laboratory (NLL, later NLR) coordinated the Dutch contribution to the European launcher.

GROC had no formal status, but in practice it decided which space science projects would be funded by the Ministry of Education and Sciences. This rather informal structure was unique: all comparable science projects such as nuclear physics were funded through the national science foundation ZWO. Even though it was often criticized for its lack of transparency and accountability, GROC's role remained unchanged until 1983. The space research budget started with a paltry ƒ500 ($130 in 1960 dollars), but it rapidly increased to ƒ1.5 million ($0.4 million) in 1965 and ƒ13.7 million ($5.5 million) in 1975.[10]

Astronomers dominated GROC almost from the start, with heavyweights such as Van de Hulst, who was its chairman, Oort and Marcel Minnaert. Another important member was H.J. van der Maas, the director of the NLL and the NIV, the two main aeronautical research laboratories. Kees de Jager, Minnaert's junior colleague at the astronomical department of Utrecht, was particularly active. His space science laboratory soon spent almost two-thirds of GROC's budget. The astronomical departments in Leiden and Groningen made up most of the remainder. These departments quickly built up considerable experience in building space rated instruments. Early Dutch experiments flew on several NASA and ESRO missions (cf De Kort 2003 206).

There are several reasons why astronomers were able to dominate GROC. Of course, his election as president of COSPAR put Van de Hulst in an excellent position to take the initiative, but Dutch astronomy had been internationally prominent since the turn of the century. J.C. Kapteyn, Oort and Minnaert had created a renowned 'school' of astronomy (Sullivan 2000; Baneke 2010). Through

[10] Budgets in GROC.

radio astronomy, the astronomers had extensive networks in industry, especially Philips, and in government circles (Elbers 2012). Van de Hulst regularly attended the meetings of the government's interdepartmental space policy committee.[11] The astronomical community had a strong institutional structure, which enabled them to coordinate their activities, resolve internal disputes, and quickly respond to new developments.

The astronomers had strong international networks as well, with many Dutch astronomers serving in prominent positions in the International Astronomical Union, for example. Oort was one of the driving forces behind the European Southern Observatory (ESO) (Blaauw 1991). Many Dutch astronomy graduates obtained fellowships at the major American observatories. Many stayed there (DeVorkin 2000). Those who came back returned with valuable skills and contacts. Jan Borgman from Groningen worked at several American institutes including the University of Arizona, where he became involved in NASA's Orbiting Astronomical Observatories program. He decided to come back to Groningen, however, where he founded a space science laboratory. Among his acquaintances in the Unites States was Nancy Roman, who became director of NASA's astronomical program.[12]

The quick move of Dutch astronomers into space research is remarkable. In the United States and in Great Britain, astronomers were initially skeptical about the possibilities of space (Massey 1986 67, DeVorkin 1992, Roman 2001 506). One possible explanation is the lack of large Dutch ground-based telescopes, which stimulated interest in alternatives such as radio astronomy and space research, as well as ESO.

Despite the scientific successes for the nation's astronomers, the industrial benefits of space for the Netherlands remained small. Fokker and Philips had hoped to secure large international contracts, but after a few years it became clear that this would not happen. They blamed their lack of experience, but also the fact that the Netherlands was a relatively small contributor to the European space organizations. Because the contracts were handed out on a more or less proportional basis, it was impossible for any Dutch company to become lead contractor on a major project. Besides, the Netherlands had already been awarded a large ESRO prize with the establishment of its technology center ESTEC in Noordwijk.[13]

In the summer of 1965, Fokker and Philips took these concerns to the Dutch government.[14] They asked for a significant increase in the size of the national space program. Large space projects would provide them with experience and know-how, while at the same time offering the opportunity to

[11] NATH, Binnenlandse Zaken records, file 5591; GROC meeting of 20-10- 1965 in GROC file 7-5; Van de Hulst 1992.
[12] Groninger Archieven, 2402 Archief Blaauw, inv. 27: correspondence between Borgman and A. Blaauw.
[13] HCH 7, Nittel report 1962.
[14] NATH, Binnenlandse Zaken records, file 5577.

demonstrate their new capabilities to potential customers. Interestingly, the expected 'spin-off' effect of space technology was fairly small. The two companies felt that they already possessed the necessary technical capabilities to pursue space projects. One Fokker engineer talked about 'spin-in'.[15] Organizational knowledge and managerial experience were at least as important as technical knowledge. This argument was used and repeated by industry lobbyists, ministry officials and politicians alike. Indeed, in the 1960s, project management was increasingly regarded as crucial to innovation. Space projects were notoriously complicated, including a wide variety of institutions and placing extreme demands on quality and precision, which required advanced management techniques to control. The Apollo project provided the prime example. It was generally hailed as a triumph of management as well as technology. The European Space Research Organization was already trying to import NASA's management methods. NASA stimulated this by demanding regular project reviews of the European satellites that were to be launched on American rockets (Johnson 2002, ch.7).

The emphasis on management skills was probably related to the Dutch policy of maintaining a 'creative' national industry, which attached much value to technical development activities. A Philips engineer viewed its space project as a large-scale experiment with systems management in a research and development project (Van Otterloo 1973). Similarly, Fokker's space activities were expected to improve the company's corporate standards, project management skills, quality control and morale.[16]

The government shared the concerns of industry and promptly called for proposals for an extended space program from both industry and the scientific community. Helped by their dominance in GROC, the Dutch astronomers were quick to claim the first Dutch satellite for their work. They carefully coordinated with Fokker and Philips. The companies mainly wanted to build a satellite; they did not much care about its application. An astronomical satellite would perfectly fill all their requirements. As they pointed out, the investment was justified by the international reputation of Dutch astronomers; there was little chance of duplication elsewhere; astronomy was easy to popularize, making the project visible and possibly creating some national excitement; an astronomical satellite would provide ample opportunity to exhibit ingenuity, while requiring relatively little development work outside the ongoing national programs; and it would not require

[15] Interview by the author with Jan de Koomen; cf. PCA, file 821:921.94 ruimtevaartindustrie, no.1b (report "Some considerations on a scientific satellite", July 1963).

[16] This argument was used, for example. in: letters from industry in NATH, Binnenlandse Zaken records, file 5577; Jaaradvies RAWB 1976, Kamerstuk 13918, Handelingen van de Tweede Kamer 1975-1976, p. 28; IRAS proposals in NRM; remarks by Minister Nelissen (Economic Affairs) in Parliament, 12-11-1970, Handelingen van de Tweede Kamer 1970-1971, pp. 940-941. Cf. interviews by the author with Reinder van Duinen and Jan de Koomen.

complicated international agreements (as a communications satellite would, for example).[17] Also, as the ESRO was the main potential future client, it was important for industry to demonstrate that it was capable of cooperating with scientists. Finally, a science satellite would be most likely to gain the crucial support from NASA. Several influential officials at the ministries of Science and Education and Economic Affairs agreed, and the Astronomical Netherlands Satellite or ANS was quickly approved.[18]

Both industry and the astronomers wanted the satellite to garner special attention. For that reason as much as for scientific reasons, the satellite would get an advanced stabilization and pointing system. For similar reasons, Philips' subsidiary Hollandsche Signaalapparaten, a defense contractor, provided a state-of-the-art reprogrammable on-board computer. The main scientific instrument to be included was a 22cm telescope from Groningen University, for ultraviolet photometry and spectroscopy. One of its goals was to investigate the absorption of ultraviolet light in the interstellar medium, which was important for the long-standing Dutch research program on the structure of the galaxy. The second instrument was a 'soft' x-ray instrument from Utrecht.

In 1970 ESRO-director H. Bondi offered the services of his organization to the project, even though ANS was explicitly built outside the European framework: "I would infinitely regret it if the Organisation's first genuine opportunity to make an important contribution to a national programme were missed".[19] Apparently, ESRO needed to defend its relevance. The organization was experiencing a series of crises around this time (Krige and Russo 2000). Eventually, ANS was tested at ESRO's technology center in Noordwijk.

According to De Jager of the Utrecht space research laboratory, Fokker and Philips did not care much about which scientific instruments would be included (De Jager 2009). That science was not the main goal of the mission for them was underlined several years later, when an ESRO mission ran into financial problems. The Dutch government considered withdrawing its support because Dutch industry was not involved in the project. The Dutch scientific instruments on board did not figure in their considerations. Eventually, it was decided to continue support – again not for scientific reasons but because withdrawing would make the Netherlands an unreliable partner in international projects.[20] This lesson was not lost on the astronomers.

The American offer to support and launch foreign (scientific) satellites was the only thing that made it possible to pursue a national space program outside the context of ESRO . Many European nations

[17] PCA file 821:921.94 no. 1, *Voorstel van de Nederlandse electronische- en vliegtuigindustrie voor de ontwikkeling van een Nederlandse astronomische satelliet,* (1966).
[18] Cf. memo January 1966, NATH, Onderwijs en Wetenschappen Records, File 585.
[19] Bondi to Hoogewegen, 20-7-1970, NATH, Onderwijs en Wetenschappen Records, File 585.
[20] NATH, Binnenlandse Zaken records, file 5586.

had accepted the offer already; Norway even declined joining ESRO altogether (Collett 1995). Dutch government officials could hardly believe that the Americans would launch their satellite free of charge, and they did not expect the offer to last for long.[21]

To the relief of Dutch government officials, NASA expressed interest in ANS and approved its launch. A Memorandum of Understanding was signed in 1970. NASA ultimately provided a slightly larger launch vehicle in order to add an American instrument to the mission, which was interpreted by the Dutch as a vote of confidence in the project.[22] The selected instrument was a 'hard' x-ray instrument built by American Science and Engineering. Together with the Utrecht experiment that covered a neighboring wavelength range, its goals included detecting cosmic x-ray emissions and identifying x-ray sources with known optical sources.

American support provided more than just a rocket and an instrument, however. From their first satellite proposal, Fokker and Philips expected to need technical support from American industry. This support was provided (for a fee) by General Electric, for example by hosting Fokker staff for a crash course in space technology. In addition, NASA supervised the project with regular reviews and advice, especially concerning quality and reliability assessment (Van Otterloo 1973).

ANS was launched by a Scout rocket in 1974. Due to a technical malfunction its orbit was more elliptic than planned. Philips' eagerness to show off now paid off, because part of the observation program could be saved by reprogramming the on-board computer. Among the most important results of the mission were the detection of several x-ray 'bursts', stellar flares and coronas, the discovery of extremely hot stars, and measurements on the extinction of light due to interstellar dust.

Because of the changed orbit, the planned full survey of the sky would take longer than originally planned. For this reason, the mission was extended from half a year to one year. Dutch Science Secretary G. Klein refused a second extension, however. The astronomers were outraged: ANS had shown that industry could build a successful satellite, but now that it was up there, it would be folly not to make maximum use of it. It became a minor public scandal. Eventually, the astronomers provided Klein with an excuse to reverse his decision without losing face by pointing to the discovery of x-ray bursts (De Kort 2003 99-100; Van Berkel 2011 405-406). NASA remained silent during this controversy.

The total cost of the mission was estimated to be close to ƒ100 million ($37 million), two-thirds of which was supplied by the Dutch Ministry of Economic Affairs. Fokker and Philips reported that

[21] Piekaar, remark in margin of a letter from GROC, 29-12-1965, NATH, Onderwijs en Wetenschappen Records, File 585.
[22] For example in a memo to the prime minister, 24-6-1976, NATH, Algemene Zaken records, file 10110; cf NATH, Binnenlandse Zaken records, file 5591.

they invested ƒ13 million between them (the actual figure was probably larger).[23] The total cost was about twice the initial estimate; it also significantly exceeded the ƒ5 million annual space budget that the government had originally envisaged.

ANS was a source of considerable national pride, although Dutch politicians were careful not to mention prestige as a motivation for such an expensive project. As the space budget ballooned, members of the Dutch parliament became restive, asking whether industry could not be supported through more useful scientific projects and questioning the ambition to compete with the great superpowers: “small countries generally don’t do national satellites, after all.” Minister R.J. Nelissen of Economic Affairs denied emphatically that it was a prestige project, referring to the economic value of learning the unique management systems that were used in spaceflight. Only after some prodding did he acknowledge the scientific value of the project as well.[24]

ANS was the first major American-Dutch cooperation in space. It was a highly a-symmetrical partnership that succeeded in fulfilling the goals of each party. It provided the Dutch with the opportunity to gain valuable experience and advertise their capabilities, which would have been impossible within the European space organizations. The Dutch benefited from American advice on technical and management issues, especially quality control. Philips reported that the quality constraints were 1000 times stricter than with the defense products it was used to.[25]

For NASA, ANS was an almost routine part of the international program that it had set up to carry out its mission of stimulating international cooperation, which was a vital part of America’s Cold War diplomacy. ANS neatly followed Frutkin’s guidelines. The project highlighted the benign, open and peaceful aspects of the American space program and, by extension, the United States itself. Both parties were happy with the project, and especially the Dutch were keen on a second mission. That mission would turn out to be very different.

The Infrared Astronomical Satellite

In the 1970s, the international situation changed significantly. After the Moon landings of 1969-73, President Nixon declared the space mission to be accomplished. NASA’s funding was cut as the nation focused on the Vietnam War, the oil crisis and social issues. The Space Transportation System (Shuttle) was the only part of NASA’s grand post-Apollo plans that would be executed. Initially, Europe was supposed to participate in the Shuttle, but the negotiations failed because of political, financial and security issues. Europe would only provide a scientific module for the Shuttle: Spacelab, Europe’s first manned space project (Sebesta 1994b; Reinke 2007 211-213). This became the main

[23] Handelingen van de Tweede Kamer 1973-1974 doc.no. 12932. Muller 1997, 86 estimates the total costs at ƒ150M, possibly correcting for inflation.
[24] Handelingen van de Tweede Kamer 1970-1971, pp. 940-941.
[25] PCA, file 821:921.94 no. 3.

focus of the German space program, just as the European launcher was a French pet project. Despite the cuts, NASA continued its scientific program, including its international activities. It initiated the development of the Large Space Telescope (later: Hubble), which would include a European instrument.

In Europe, ESRO and ELDO experienced a series of financial and political crises. Especially the development of a European launch vehicle ran into severe problems. Great Britain even threatened to withdraw from the project. France and other countries reasoned that the breakdown of the post-Apollo negotiations and American reluctance to launch European communications satellites underlined the importance of an independent European launch capability (Sebesta 1996). At the same time, increased European cooperation and the détente in the Cold War made the military aspect of the launchers less sensitive. This made it possible to merge ESRO and ELDO into a single European Space Agency (ESA) in 1975 (Krige and Russo 2000). J.H. Bannier, the influential director of the Dutch National Science Foundation who was also involved in CERN and ESO, played an important role in the negotiations that led to the new organizational structure. All member states of the ESA were obliged to contribute to its science program, which gave it a relatively stable funding perspective, albeit on a lower level than before. The other projects, including Spacelab and the launcher (later Ariane), were optional.

The relation between America and Europe changed as well. Europeans became increasingly critical of America, as the latter battled with a series of crises. Meanwhile, détente drew American attention away from Europe, towards the Soviet Union and China. The Apollo-Soyuz Test Project in 1975 symbolized this, at the very time when negotiations about European involvement in the Post-Apollo plans failed.

One thing did not change, however: Dutch industry was still unable to secure major space contracts. The Dutch remained a small contributor to ESA, and a joint proposal with Germany for a large astronomical satellite ('Gernelas') failed (Krige 1992). The ANS project had led to some contracts for Spacelab, but as Minister Ruud Lubbers of Economic Affairs told Parliament in 1974, without a second national project, the country risked losing the knowledge and skills that it had gained from ANS.[26] The planned second Dutch satellite was initially known as ANS-B, as it was supposed to use the same basic design as the first one.[27] It was primarily promoted by Fokker, using the by now familiar arguments about the importance of technical and managerial experience for industry and innovation. As before, Fokker preferred a scientific over an applications satellite. Besides, cooperating with astronomers had worked out well the first time.

[26] Handelingen van de Tweede Kamer 1974-1975, doc.no. 13100 XIII; and idem, 1975-1976, doc.no. 13918, p.28.
[27] PCA file 821:921.94 no. 3.

In contrast to Fokker, Philips decided that it had no future in space technology. The company feared that the national space budget would not be sufficient to provide it with a constant stream of contracts. Its complex internal structure, which meant that four semi-independent divisions had been involved in ANS, had made the previous project difficult to manage. An emergency reorganization had solved most of the problems, but internal estimates suggested that the project cost the company up to ƒ17,5 million. Philips' management concluded that space projects were too inefficient and unpredictable. Besides, it also expected that the future of spaceflight would be dominated by the Space Shuttle rather than free flying satellites. This was a common expectation at the time – some people thought the Ariane launcher would be obsolete before it was built - but Fokker was skeptical about the Shuttle. Philips promised Fokker to support its lobbying efforts for a second satellite, however.[28]

The chances for a new satellite were boosted because space projects perfectly matched the new economic policy of the Dutch government in the 1970s. They used modest amounts of energy and raw materials and relied almost exclusively on highly skilled labor.[29] Furthermore, in 1973, the management consulting firm McKinsey & Company, a regular consultant of the Dutch government, wrote that public investments in space technology were desirable. The future economic potential of space was unclear but probably large. In the near future, however, government support would remain necessary. McKinsey advised the government to listen carefully to the wishes of Philips and Fokker, and to adjust its policy accordingly.[30] This is exactly what happened. The government approved the new satellite project, with the Ministry of Economic Affairs again supplying most of the funding.

The new satellite was called the Infrared Astronomical Satellite (IRAS) (Waldrop 1983; Tucker and Tucker 1986). Its goal was to make a complete survey of the sky in the infrared, in order to observe relatively cool objects and to investigate interstellar dust. It was based on an idea from the Groningen group of Jan Borgman. At a GROC brain storm in 1971, Oort and Van de Hulst had emphasized that building an infrared satellite would only make sense if the Netherlands could compete in the very front rank of science.[31] This required quick action because infrared research was a highly competitive field. For that reason, the astronomers were eager to join Fokker's new project.

The plan for IRAS was extremely ambitious. Both its technological challenges and its cost would require significant American support. The nature of the proposed cooperation was expected to be

[28] Ibidem.
[29] IRAS proposal 1974 in NRM; Kieboom to Lubbers 26-1-1976, and report *Ruimtevaart en nationale doelstellingen,* 1976, NATH, Algemene Zaken Records, File 10110.
[30] McKinsey report 1973, NATH, Algemene Zaken Records, File 10110.
[31] Minutes of GROC brainstorm 10-11-1971, HCH, box 53; cf Oort to De Jager, 19-11-1962, Leiden University Library, Oort papers, file 272c.

similar to ANS, with NASA providing a launch vehicle and one or more instruments. The proposal for launch assistance that was submitted to NASA in August 1974 included room for unspecified American instruments.[32] But IRAS also required specific technology that was only available in the United States. Infrared instruments had to be cooled down to a few degrees above absolute zero to prevent interference from heat radiation from the instrument itself. Such a cooling system had never been accomplished in a satellite. A breakthrough came when Ball Brothers Research Corporation presented a design study for a Stanford satellite experiment (Van de Hulst 1992 132; Everitt 1992). The company, which had already worked on several Dutch space instruments, became one of the main contractors on IRAS. The infrared detectors also posed a problem. Detectors for short wavelengths had been developed for military purposes, to detect missile launches, but sensitive detectors for longer wavelengths still had to be developed. Assembling the detectors in an array also proved extremely difficult.[33]

But in the early 1970s, plans for an infrared telescope were widespread. When NASA published an 'Announcement of Opportunity' for a scientific satellite in 1974, 13 of the 121 submitted proposals involved infrared experiments. They came from various American groups that included pioneers of infrared astronomy such as Frank Low (University of Arizona and Rice University), Gerry Neugebauer (Caltech), Martin Harwit (Cornell University) and Russell Walker. The latter had previously been involved in classified infrared surveys for the US Air Force. When it was finally published, many astronomers were critical of its accuracy. Combined with the increased availability of detectors, this explained the sudden interest in the topic. Oort and Van de Hulst had been right: infrared astronomy was a highly competitive field (Harwit 2001, Low et.al. 2007, Price 2009).

The Dutch and American proposals arrived around the same time at NASA headquarters. Nancy Roman and Nancy Boggess of NASA's astronomy program were very supportive. They had systematically supported the exploration of new parts of the electromagnetic spectrum in the past. After ultraviolet, x-ray and gamma ray observations, infrared was next on the list (Roman 2001). NASA asked representatives of the most promising American proposals and the Dutch team to define a single joint mission between them. This procedure was not unusual. The selected proposals also included cosmic background radiation observations, which required similar technology.

This forced merger has been described as a 'shotgun marriage' by some of those involved, and the first meetings were far from friendly (Van de Hulst 1992 133; Tucker and Tucker 1986 143; Mather and Boslough 1996 124). The Dutch feared that the Americans would not take them seriously because they represented small astronomical institutes, while the Americans were mostly

[32] IRAS proposal 1974, NRM.
[33] Interim report on The IRAS mission definition by Walker, 19-9-1975, SRON; see also Waldrop 1983; Price 2009 237-341.

backed by large, engineering-oriented organizations. Moreover, the Dutch had little experience in infrared astronomy. Indeed, the American teams were not sure what to make of this unknown team that had not had to pass a competitive selection, as the American proposals had. On the other hand, the reputation of the Dutch astronomers was an asset. One of them quoted Low as saying “if we must have partners, then by all means let them be Dutch astronomers”.[34]

The American scientists also disliked some of features of the Dutch proposal. They criticized its relatively small size and the intention to filter noise out of the data before transmitting it down to Earth. This was but one of the many problems that had to be solved in order to integrate the Dutch project with the American ones.[35] Matters were complicated further by tensions between some of the American teams. It soon became clear that there would be little room for cosmic background observations. John Mather (NASA Goddard) and his team withdrew from the mission, hoping to secure their own dedicated satellite. Their gamble paid off: the Cosmic Background Explorer (COBE, launched in 1989) earned Mather and George Smoot a Nobel Prize.

The stakes were high. The Dutch scientists were dependent on American cooperation to launch IRAS (the joint satellite kept that name), to give access to crucial technology and to provide additional funding. But the Americans were dependent on the Dutch as well. It was an extremely complex project using untested technology, at a time when NASA’s resources were stretched to the limit by the Shuttle, the Voyager missions and the Space Telescope. As an international project, it would be harder to cancel if it ran into trouble. Besides, the foreign contribution made it possible to include IRAS in NASA’s Explorer budget, which was not subjected to yearly Congressional approval, as most large NASA projects were. If the price was to let the Dutch build the spacecraft and join the scientific planning, it was probably worth it. According to several commentators, there would have been no American infrared astronomy satellite without a European contribution.

Eventually, a single joint mission was defined. It would make a complete sky survey with some remaining time for selected observations with the ‘Dutch Additional Experiment’ (DAX), a spectrometer. By this time, the satellite design had grown to more than 1000kg (compared to ANS’s 130kg). The mission was expected to last for about 220 days before its cooling helium ran out. This well-defined lifetime prevented a repetition of the problems of the ANS mission. Despite these changes, the contribution of Dutch industry remained similar to their planned role.

The increased weight of the satellite made it significantly more expensive. The estimated Dutch contribution would be around ƒ165 million ($66 million), against an American contribution of ƒ140 million ($56 million, probably excluding launch costs). At the request of the Dutch government, the

[34] Van der Laan to Borgman, 11-4-1975, SRON, file IRAS correspondence 1975.
[35] Mather and Boslough 1996 124; See also: minutes 24/25-6-1975, SRON, IRAS files. The Cornell proposal was closest to the Dutch one.

British Rutherford Appleton Laboratory was found willing to provide the ground station for tracking, telemetry and initial data processing. This contribution was valued at about £10 million, or 10% of the total project. For bureaucratic reasons, it was considered to be a part of the Dutch share, but it was funded by Britain's Science Research Council. The British contacts may have originated in aborted talks about a German-British-Dutch x-ray satellite (Linssen 1977).

Transatlantic cooperation on this scale required diplomatic expertise in addition to technical. The small European countries shared their experiences: Van de Hulst advised Danish astronomers on how to establish a space program, while the Dutch solicited information from a Swedish delegation about working with NASA.[36] On the American side, NASA's international officer Frutkin advised the Jet Propulsion Laboratory (JPL) on how to deal with the Dutch. He told them to expect some cultural differences, for example in management approaches, and to be aware of the budget constraints of a small country. He also emphasized that the Dutch should be treated as 'equals in status', and never as 'contractors responsible to us or to be directed by us'.[37] The necessity of this warning was illustrated later, when a senior NASA official described the European Spacelab efforts in precisely those terms (Sebesta 1994).

The design and construction of IRAS was troublesome right up to the launch. It suffered technical problems but was also caught in the problematic relationship between NASA centers Ames and JPL.[38] The detector array had not yet been finished when the telescope system was shipped to Holland to be 'mated' with the spacecraft. The operation could not be postponed, however: the transport had a high media profile and the Dutch insisted that the mating be done in Fokker's facility in Amstelveen. In the event, an empty mock-up of the array was used, which was quietly replaced later. These and other problems increased the American contribution to IRAS to more than $100 million (ƒ280 million in 1983). NASA provided the required additional finance by delaying the next Explorer missions. COBE was the main victim of this policy (Mather and Boslough 1996 175). IRAS was finally launched on 25 January 1983 with a Thor-Delta rocket. Everything went according to plan: the satellite was delivered 'within one foot' of the planned orbit (Tucker and Tucker 1986 153-154). The mission lasted until the helium supply ran out, about 300 days.

The main results of the IRAS mission were a boon for astronomy. The earlier Air Force surveys had been based on a total of approximately 30 minutes of observation time; now there was a survey based on many months of careful observation, including thousands of new infrared sources.[39] The

[36] HCH, files 26 and 55.

[37] Frutkin to B. Murray, 21 June 1976, NASA Historical Reference Collection, record no. 006069.

[38] *Infrared Astronomical Satellite: Technical Lessons Learned* (JPL 1983), National Air and Space Museum, Washington DC, IRAS accession files; cf. Waldrop 1983, Tucker and Tucker 1986 150.

[39] Catalogues at http://lambda.gsfc.nasa.gov/product/iras/i_products.cfm; see also a special issue of *Astrophysical Journal,* January 1984.

most eye-catching discoveries included several comets and a dust cloud surrounding Vega, which was interpreted as a possible indication of planet formation. Rumors about the discovery of a tenth planet in the solar system drew a lot of attention but proved to be false.[40]

Initially intended to simply be a bigger copy of ANS, IRAS instead became a major big-science project with a radically different relationship between the collaborators. It was not a Dutch satellite that was generously supported by the American hegemon, but a joint project in which both sides were equally dependent on one another. Another example was ESA's contribution to the Hubble Space Telescope, which helped NASA to obtain political approval for the project (Smith 1993). As we have seen, this change was not only the result of increasing European self-confidence and independence. It was the result of political, economic, scientific, and institutional developments on both sides of the Atlantic. Adjusting to the new situation was challenging for both sides.

After IRAS

Plans for a third Dutch-American satellite were well underway by the time IRAS was launched, but in the meantime, the international context had changed again. The European space program had matured. Its budget was still much smaller than that of NASA, but the perpetual crises of ESRO and ELDO seemed to have ended. The Ariane launcher project finally bore fruit, and the Challenger disaster of 1986 made it a desirable alternative launch vehicle for both scientific and commercial satellites (Logsdon and Reed 1999). At the same time, possibilities to cooperate with the Soviet and later Russian space program increased, further reducing European dependency on America. Several European experiments flew on the USSR's space station MIR. With Spacelab, ESA even had its own manned space program. In 1985 physicist Wubbo Ockels became the first Dutch astronaut. Spacelab was still dependent on American infrastructure, as it had to be flown on a Space Shuttle. NASA kept providing this support, just as it kept supporting several other joint space projects. Its continued participation was no longer self-evident, however, as was illustrated by NASA's withdrawal from the International Solar Polar Mission in 1981.

In the Netherlands, the new governments of Dries van Agt and Ruud Lubbers cut national spending, leaving less room for expensive technological projects. Rather than supporting the work of a few national industrial champions, new policy was aimed increasingly at medium and small companies (though Philips and Fokker kept receiving significant support behind the scenes). The government adopted a more complex policy of stimulating small-scale cooperation between industry and academia through contract research (Van Helvoort 2005; Van Berkel 2011). At the same time, university education was restructured for political as well as financial reasons. As budgets

[40] See for example www.badastronomy.com/bad/misc/planetx/science.html

became tighter, Dutch ambitions on the world stage were toned down. As Hellema has argued, Dutch international policy was free from inflated pretentions for the first time (Hellema 2009 269).

The policy changes had direct consequences for the space program. In 1980, the Science Advisory Council (RAWB) stated that the economic returns of the program had been disappointing so far, both in terms of spin-off and contracts for Dutch industry. It felt that space should become an economically sustainable activity, independent of large-scale government support.[41] The result was that the space program was adjusted to a level 'appropriate for a small country'. GROC was informed that it had to secure at least 15% of its funding from contract research. Naturally, the Ministry of Economic Affairs was no longer prepared to fund a third satellite.[42] In future, all instruments would have to be launched on ESA and NASA missions. Germany and several other European countries also completely Europeanized their space programs. Only France, Italy and Great Britain maintained substantial national programs (Reinke 2007).

In 1983, GROC became the *Stichting Ruimteonderzoek Nederland* (SRON), funded through ZWO instead of the Royal Academy. This made the institutional structure of space science similar to, for example, radio astronomy and nuclear physics. Infrared instrumentation remained a specialty, with major Dutch instruments for ESA's Infrared Space Observatory (ISO), XMM-Newton and Herschel missions, for example.

By the 1980s, the confluence of political, industrial and scientific interests that had made ANS and IRAS possible had ended. The Dutch space industry never became a significant economic sector, even though Fokker's space activities survived the bankruptcy of the company in 1996. As 'Dutch Space' it is now part of the European aerospace conglomerate EADS.

Conclusion

The Netherlands did not necessarily want Europe to become the third space power, but if France, Britain and Germany did, it wanted to be part of it. For a small but ambitious country, 'being involved' and being taken seriously meant that it had to join from the very beginning. It also meant that it had to develop expertise and experience in the relevant fields, which in this case included both technological know-how and project management skills.

Both ANS and IRAS originated in the ability of two powerful national companies to mobilize large-scale government support, and both were shaped by the Dutch astronomical community's ability to take full advantage of the opportunities presented to them by the constellation of political and economic interests. The government was happy to use the country's national strengths in industry and astronomy to realize its international ambitions.

[41] RAWB *Advies inzake ruimtevaart* 1980, HCH, file 123.
[42] Letter from Pais, 5-11-1980, GROC 347-9/10.

Between ANS and IRAS, the relations between Europe and America changed. Cold War politics and domestic issues turned America's focus away from Europe, while the European space organizations became increasingly self-confident. The hierarchical relation became less pronounced, as America increasingly also used European support for its projects. Of course, the relation was still not equal; NASA's budget still dwarfed ESA by a considerable margin.

Neither the Dutch nor the European space program was a direct consequence of Cold War rivalry. Competition within Western Europe and between Europe and the United States was more important than competition with the Soviet Union. Nevertheless, America's Cold War politics defined the limits of possible European space activities, especially before Europe finally acquired its own launcher in the 1980s. American influence on the European space program was not as direct as its influence on European science in the immediate post-war years, but perhaps that was not necessary. By the 1970s, European institutions had been (re)established and Western Europe's position in the Cold War was clear. Still, the United States remained heavily involved in European affairs. That the advantage went both ways explains much of this persistence. For a small country, collaborating with NASA made it possible to pursue an independent space program in addition to the joint European efforts.

ESA-director Reimar Lüst once characterized the American-European relation in space as US tutorship until the 1970s, Europe as junior partner until the mid-1980s, and finally partnership and competition (Krige and Russo 2000 375). As we have seen, this is a fair description of the developments, but it was not a planned learning trajectory, as Lüst seems to suggest. Forced by American post-hegemon politics into the role of an equal on IRAS, the members of the Dutch space program found themselves equal to the task. This was in no small part due to ANS, which had laid the groundwork for independent Dutch capability in space. For most of the actors in the Dutch space program, science was not the goal but the means. Yet it could be argued that astronomers benefited most from the aspirations of the Dutch space program. Astronomy was a convenient vehicle for the ambitions of others, and the astronomical community was able to make the most of these roles. In the end, they used industry and politics as a vehicle as much as the other way around.

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GROC: Papers of the Geophysics and Space Research Committee, Royal Netherlands Academy of Sciences, Amsterdam

HCH: Henk van de Hulst papers, Leiden Observatory, Leiden

NACP: US National Archives, College Park, MD

NATH: Dutch National Archives, The Hague

NRM: Nationaal Ruimtevaart Museum Archive, Aviodrome, Lelystad

PCA: Philips Company Archives, Eindhoven

SRON: Netherlands Institute for Space Research, Groningen

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