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# Norwegian Space Activities 1958-2003

## A Historical Overview

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# Introduction

Norway joined the European Space Agency (ESA) as a full member in 1987. The road to Norwegian membership proved to be long and difficult. Norway first abstained from joining the European Space Research Organisation (ESRO) in 1962, and, in a second round, halted a new attempt at applying for membership in 1967. Proposals for Norwegian membership in the reorganised ESRO/ESA were taken up in 1970 and then again in 1973, but were rejected by the government in 1974. Norway remained an observer in ESA, as in ESRO, until 1981 when it became an associate member. Finally, in 1986, the Norwegian parliament – the *Storting* – approved the government proposal of full Norwegian membership in ESA.

During this period, Norway was, however, actively involved in international space cooperation, in both scientific research and in space technology applications. In space-related activities, as in other forms of international cooperation, Norway participated in three arenas – one Scandinavian, one European and one Atlantic (with the United States as the major power). Within Europe, Norway enjoyed privileged relations with ESRO throughout the 1960s and later participated in the Marots programme under ESA. In space research, Norway cooperated with Europe and the United States, and in telecommunication, Norway was a member of Intelsat and Inmarsat which owned and operated worldwide networks for its member countries.

Since joining ESA in 1987, Norwegian space activities have mainly been focused on the efforts and payoffs within the European arena for space cooperation. However, it has also had multiple projects on an autonomous, national level and has, at the same time, continued to expand its cooperation in space-related science and industrial development with non-European partners.

Since 2003, issues concerning the size and scope of Norway's involvement in space activities have resurfaced. Norway has made very good use of its ESA membership and has benefited in terms of contracts and challenges for Norwegian technology companies and research groups. But there have also been problems in establishing, administering and maintaining activities in certain areas, particularly in space science. Only a few years into the new millennium finds Norway dealing, yet again, with the classic dilemma of small states in a 'big science', 'big industry' and 'big everything' context.

## The Early Years of Norwegian Geophysical and Cosmic Science

The historical background of Norwegian space activities was the establishment of research groups and infrastructure, and the development of scientific talent that concurred with the gradual liberation and foundation of a sovereign Norwegian state during the late 19th century and the beginning of the 20th century. During the first half of the 20th century, Norway nurtured schools of geophysical and cosmic sciences to international prominence. Following World War II, distinguished researchers[1] in these fields secured institutional positions which facilitated Norway's entry into the dawning age of sounding rockets.

It seemed natural that Norway should assume a major role in geophysical, especially polar geophysical, studies due to its geographical location. The possibility to experience dynamic changes in atmospheric and oceanic conditions, where the Gulf Stream and mild Atlantic air confront arctic currents and polar air masses, is unique. But Norway was a small and relatively poor nation, lacking financial as well as cultural resources. While in other European countries new experimental findings and theoretical postulates were opening up atomic physics in the early 20th century, Norwegian physicists largely turned to nature-in-the field to advance physical science. Given the shortage of laboratory facilities and the paucity of academic positions, these scientists managed to channel their curiosity and energy into problems that held promise for winning unique national honour and assisting the material and social development of the nation.

Kristian Birkeland opened a new era for the study of terrestrial magnetism, auroral phenomena and cosmic geophysics. He established an observatory at Haldde, on the mountain Bossekopp in northern Norway in the late 1890s. Carl Størmer followed Birkeland's efforts in auroral studies and furthered these using photographic equipment.[2] The activities and infrastructure initiated at Hallde by Birkeland, and developed further by scientists such as Ole Andreas Krogness, Olaf Devik and Vilhelm Bjerknes, had spreading consequences for the scientific activities of the region. In 1917, the Norwegian government moved to establish a geophysical institute in Tromsø, which quickly won approval in the Norwegian parliament.

Although Norwegian scientists were internationally recognised in geophysical science, all was not well. The continuing economic crisis during the 1920s prompted the government to consider closing the observatory at Hallde; additionally, auroral studies in Tromsø ran into difficulties. In this climate, the Rockefeller Foundation's programmes for assisting the natural sciences in the United States and abroad came as a significant and decisive opportunity and aid to Norwegian researchers, helping them to save and uphold scientific capacities during a period that was generally characterised by a downturn in both financial and academic matters in Norway. Following a proposal by Lars Vegard, the Norwegian Institute for Cosmic Physics – the actual facility came to be known as the 'Auroral Observatory' – was opened in Tromsø in 1930, backed financially by the Rockefeller Foundation. In Oslo, the astrophysicist Svein Rosseland managed to obtain the Rockefeller Foundation's support for the construction of the world's first Institute of Theoretical Astrophysics (IFTA), which opened in 1934.[3]

By the eve of World War II, Norwegian geo- and cosmic scientists had established an institutional and professional infrastructure that supported internationally prominent research programmes. Funds and job possibilities remained in short supply, but were sufficient to nurture new generations of practitioners. After WWII, science in Norway, as elsewhere, entered a new era. In the fields of physical science that the United States began to enter with massive personnel and material resources, few if any nations could compete. Geophysical and space sciences were accepted to be directly and indirectly important for national security. The International Geophysical Year (IGY, 1957/58), propelled these sciences into new,

[1] Notably Kristian Birkeland (1867-1917), Vilhelm Bjerknes (1862-1951), Carl Størmer (1874-1957), Lars Vegard (1880-1963), and Svein Rosseland (1894-1985).

[2] Størmer took up the challenge of calculating mathematically the trajectories of the captured solar particles in the Earth's dipole magnetic field.

[3] In 1937, the world's largest calculating machine at that time – a differential analyzer – was assembled at the institute, also paid for by money from the Rockefeller Foundation.

almost unthought-of of heights of accomplishment – in many cases revolutionising conceptual and methodological foundations. United States and Soviet investigators dominated the ever-rapidly expanding research frontiers. Still, smaller national communities with strong traditions and institutional infrastructure could find disciplinary niches in which they continued to make significant contributions. As Norwegian specialists faced the new age and considered strategies for renewal and growth, they were somewhat aided by the accomplishments of the past. The great authority and prestige that pioneers such as Lars Vegard, Harald U. Sverdrup, Svein Rosseland, Leiv Harang and Odd Dahl[4] had attained enabled them to assume important strategic positions in new organisations that were established as the age of research councils and policy began. They helped shape the continued growth of these sciences while positioning Norway to enter the space age.

[4] Harald U. Sverdrup (1888-1957), Leiv Harang (1902-1970), Odd Dahl (1898-1994)

# The First Steps Towards a National Space Research Policy in Norway

By the end of the 1950s, the joint European efforts were underway to challenge United States and Soviet Union supremacy in space research and technology. The years between 1960-1962 were decisive for the process of formulating national strategies for participation in the new field of scientific and technical endeavour. In Norway, parallel to other countries in Europe, moves were made at the turn of the decade to establish an organisation responsible for the definition of a national policy in space. Up to the late 1950s, no central organisation for coordination of Norwegian space-related research had been formed or needed. 'Space research' had not been established as a unified concept. Various institutions and groups of scientists had been studying different aspects of the atmosphere and outer space, each from their respective traditions, and from their institutional and scientific programmes.

The first moves towards a coordination of space-related research on a national level were taken as part of the preparations for Norwegian participation in the International Geophysical Year (1957/58). A national committee was formed under the auspices of *Det Norske Videnskabs-Akademi i Oslo* (the Norwegian Academy of Science and Letters) and dissolved after the IGY work was completed.[5]

The Norwegian Space Research Committee was established in late January 1960; although quite differently from the national committee for the IGY two years earlier. The Space Research Committee was established by *Norges Teknisk-Naturvitenskapelige Forskningsråd* (NTNF: the Royal Norwegian Council for Scientific and Industrial Research), not by *Videnskabs-akademiet* or *Norges Allmenvitenskapelige Forskningsråd* (NAVF: the Norwegian Research Council for Science and the Humanities). This signified a shift of focus towards what efforts in space-related science and industry would mean in Norway.

The creation of a national space research committee in Norway was also a direct response to the Edoardo Amaldi and Pierre Auger initiative for a European civilian space research organisation. The first suggestion that NTNF take the initiative to coordinate space research on a national level seems to have been made in early December 1959, in an exchange of notes between Finn Lied[6], director of the Norwegian Defence Research Establishment (NDRE) and people in the Ministry of Defence, with references to Amaldi and Auger.[7] The Norwegian case illustrates how Amaldi and Auger were successful in inspiring the establishment of national committees with responsibility for space research in each country, but the national committee was the solution to another urgent need as well.

NASA's policy of space research cooperation laid down in the declarations made by NASA officials in 1959, demanded that there be one unified, civilian body responsible for the whole field of space research in each country that wanted to cooperate with NASA. With a national committee in Norway, those conditions would be met. The Amaldi and Auger initiative was crucial in its timing. It arrived at a time when each European country had begun to discuss how to respond to NASA's offer of scientific and technological cooperation.

## Two research councils, and two ways of dealing with science administration and policy

There was little discussion in Norway concerning which authority should establish the national committee for space research. NTNF seems to have been the natural authority to take the initiative. NTNF was established by a decision in the Norwegian Parliament, the *Storting* on 10 July 1946. It asserted itself as an active and independent body, showing considerable initiative and ability to get things done in Norwegian research. The NTNF leadership established itself as privileged advisors to the government. It also proved its ability to create consensus around national research priorities across the boundaries of

[5] Chairman of the National Committee for the IGY was Leiv Harang, at the time professor of ionospheric physics at the University of Oslo and senior scientist at Norwegian Defense Research Establishment (NDRE), which was arguably the most important centre for ionospheric physics in Norway and played a central part in the IGY activities.
[6] Finn Lied (1916-)
[7] Memo from F. Lied to E. Himle 2.12.1959, with copy to R. Major, NTNF (NTNF arch.).

government, academia and industry, especially in the case of Norwegian research in atomic energy in the late 1940s.[8]

There was a striking contrast between the two research councils, NTNF and NAVF, which, in 1960, existed side by side in Norway. NTNF was intent on showing initiatives and on formulating programmes for national priorities, whereas NAVF regarded itself more as a service institution to basic research in academic institutions. NTNF built new research institutions; NAVF supported universities. When NTNF appointed its own staff of permanent researchers, NAVF had no permanent scientific staff of its own. NTNF launched programmes, whereas NAVF received applications and distributed grants to researchers on purely academic criteria.

The key difference between the two councils derived from their missions. NAVF had basic research as its main responsibility. NTNF assumed the responsibility for mission-oriented research for both government and industry. However, the boundaries between the two councils' fields of action were far from clear. Before 1960, NAVF had been the most important funding source for ionospheric physics, outside of NDRE's budget. NAVF had funded Norwegian participation in the IGY and had contributed to the extension of the Auroral Observatory in Tromsø. NTNF had remained deaf to requests for funding ionospheric and auroral studies. These were fields of basic research that should be left to NAVF, was the opinion of the NTNF's administration.[9]

However, when the suggestion was made for NTNF to take responsibility for a national programme in the technology-oriented field of space research, this fell nicely in line with NTNF's actions in its 14 years of existence up to 1960. In one way, it could be seen as a reiteration of its successful conversion of Norwegian nuclear energy research from military into civilian organisational forms in 1948, albeit on a much smaller scale. In fact, the most influential members of the first Space Research Committee had been very active in the nuclear research programmes back in the late 1940s.[10]

NTNF formally established a (preliminary) Space Research Committee on 22 January 1960. Professor in Astrophysics at the University of Oslo, Svein Rosseland, at this time a science policy veteran in Norway, was chosen to be the chairman of the committee. In addition, the committee was composed of NDRE experts on ionospheric physics, Leiv Harang and Finn Lied, and NDRE rocket propellants engineer Hans C. Christensen[11]. Furthermore, the committee had the almost legendary Norwegian wizard in technical and scientific engineering, Odd Dahl, as a member, with Harang's associate at NDRE, Bjørn Landmark, as secretary.[12] The committee was asked to give advice on 'how and to what extent' Norway should take part in space research, to propose adequate measures for space research to be taken nationally and, finally, to advise on how Norway should participate in international space research cooperation, and how international cooperation and the national activities should be viewed as a whole.

On the European scene, the Amaldi and Auger initiative had gained the upper hand on NATO plans (discussed within an Advisory Group on Space Research formed by the NATO Science Committee). At a meeting at the Royal Society in London on 29 April 1960, about twenty scientists from ten West-European countries met to discuss the European alternative. Svein Rosseland represented Norway. One of the main points was that a preparatory committee for carrying out the plans of the resolution was to be established through formal endorsement by the governments, and at the next meeting to discuss the plans, national delegates would meet as formal representatives of their governments. In Norway, this was swiftly arranged, with Rosseland being given the status of representing the government. He then

[8] NTNF had succeeded in maintaining and reinforcing its independence. Members of the NTNF Council were nominated by government, by industry and by academic institutions, and NTNF had acquired an independent status and had escaped most of the constraints common to public agencies.
[9] Interview with Anders Omholt, 17.2.1995
[10] The chairman, Svein Rosseland, had been Chairman of the NTNF's Nuclear Committee of 1947. The other senior member of the committee, Odd Dahl, was the one who had actually constructed the nuclear reactor at Kjeller. The third member, Finn Lied himself, was a member of the board of IFA, where he took over as chairman in 1960.
[11] Hans C. Christensen (1915-)
[12] Bjørn Landmark (1927-)

represented Norway at a meeting in Paris in June 1960 where the Preparatory Commission for European Collaboration in the Field of Space Research (GEERS) was constituted. This meant that Norway was now formally backing the process that would lead to the formation of ESRO. However, there were still difficulties and much uncertainty about what sort of organisation would evolve. The NATO initiative was brought to a standstill, but other organisational developments were soon to take place to alter the course of events.

So far, the process of formulating a Norwegian policy towards European space research cooperation was in the hands of the NTNF committee and overall leadership. The government gave this little attention. From the government's point of view, this was a process of scientific cooperation that the Research Council should handle on its own. However, towards the end of 1960, the situation was reversed, and European cooperation in space research became a matter of importance at government level in Norway, as well as in a number of other European countries. One important reason for this was the proposal by the British government for a programme for the development of a satellite launcher, based on the British Blue Streak rocket, in which Norway also was invited to participate.[13] Two parallel projects for cooperation were now on the agenda: the Amaldi and Auger initiative and the British initiative. Questions arose as to whether European scientific cooperation would need a European launching capability at all, in light of promises NASA and the United States government had made on providing launchers for European research satellites.

In light of considerations at the international level, a report from the NTNF preliminary Space Research Committee, presented in October 1960, was careful in its wording and cautious in its recommendations.[14] The report mainly stated that Norwegian decision-making in space research had to be tuned in to a European process of organising space research on a national and an international level, but not without keeping an eye on the development of other forms of international cooperation. One way to assure Norwegian scientists' access to new technology, in the committee's view, was through the establishment of a national launch site at Andøya, in the northern part of Norway. United States military agencies and NASA had already expressed their interest in cooperating in rocket launches from Andøya. A launch site in the auroral belt would presumably provide Norway with a trump card in future European scientific negotiations. The committee's report downplayed the importance of possible European cooperation and very briefly treated the possible industrial 'spinoffs' from space technology considering the development of satellites. The main conclusion from the committee could be summarised as a programme for scientific exploration of the auroral zone with the use of sounding rockets. The report recommended a space science programme with the help of new technology purchased at a low price. It was not a programme for space technology development. As a fairly low-cost programme it was approved without any comment in the NTNF Executive Committee. The Ministry of Industry also gave its approval, but gave no promise of extra funding.

At the end of 1960, NTNF appointed a permanent Space Research Committee. Odd Dahl was made chairman, after Svein Rosseland had declined. The committee's mandate was phrased such that it should both strengthen the scientific activity in space research and work for the transfer of new technology developed in this field of research to national industry. The committee should also act as NTNF's advisor in questions concerning Norwegian participation in international space research cooperation. Both these addenda to the committee's mandate implied that it would have a much larger field of responsibility than the previously defined administration of a modest national space research programme.

## European politics and Norwegian priorities – ELDO and ESRO

The following months witnessed a turmoil of negotiations at political and scientific levels, where national science policy would be even more closely woven into a complicated web of European organisational initiatives. The Meyrin-Conference, in late November 1960, revealed that opinions were sharply divided on the question of whether scientific cooperation should comprise cooperation in launcher development

[13] Through an aide memoire from the British Ambassador in Norway of 2 September 1960, the Norwegian government was officially invited by the British government to take part in a cooperative agreement.
[14] Innstilling fra romforskningsutvalget, Oct. 1960 (NTNF arch.).

or not. As part of a campaign to strengthen the British-French launcher concept, the British Minister of Aviation, Peter Thorneycroft, visited Norway in mid-January 1961 with an invitation to an intergovernmental meeting to be held in Strasbourg later that month, to discuss an agreement on launcher technology development.[15]

This turn of developments led to divided opinions among the small group of Norwegians who were engaged in the process of forging a national space science policy. Developments had also led to an extension of this group. Now, both the Ministry of Foreign Affairs and the Ministry of Industry were engaged in the process. Moreover, the questions under examination grew increasingly complex. Should the Norwegians take part in both of the projects: the scientific cooperation and the launcher development cooperation?

The first reactions in the Norwegian scientific circles towards the launcher project had been rather negative, but there were two points of view that define the main discourses within early considerations of Norwegian efforts in space activities. These two views point to the existence of a generation gap in Norwegian science policy-making in general. On one side, there was the view of a younger generation of science politicians – represented by Finn Lied in particular – with a more rationalistic or instrumental approach towards the use of science in society. This side argued that if Norway were to participate in this large project, there would have to be a transfer of expertise from other projects that were already under strain from lack of trained manpower in science and engineering. The other side, a more old-standing science policy generation represented by Odd Dahl and Svein Rosseland, pointed towards other considerations based on the belief in science as a cultural value, especially basic science. Dahl's attitude tended to lean towards a possible participation in both the launcher and the space science projects since he was convinced that there should be a connection between the two, and he saw this in light of possibilities to distribute projects of technological development to the Nordic countries. Dahl was, at the time, deeply engaged in efforts to facilitate satellite development and construction in Norway and Scandinavia as a whole.

After a Norwegian delegation attended the Strasbourg Conference in late January 1961, with the launcher project on the agenda, the question of participation was discussed in the Norwegian government.[16] These deliberations revealed some of the basic ambiguity of the proposed European cooperative project. In spite of NTNF's conditional support, the Ministry of Industry concluded that in relation to the possible benefits to technological and industrial development in the field of satellites, these considerations alone would not justify the significant costs of Norwegian participation. The Norwegian Foreign Minister, however, was in favour of joining on foreign policy grounds, especially if Denmark and Sweden joined. When industrial considerations alone could not justify the expenditures, the Minister of Industry argued that the decision must be taken chiefly on foreign policy grounds and, consequently, the costs should not be regarded as a research allocation, and should not displace funding for ordinary research and educational activities. From a foreign policy angle, the situation was highly unclear when the cabinet discussion took place in mid-March 1961.[17] Therefore, the conclusion of cabinet deliberations was that the government was inclined to refuse the offer of participation in the project.

The efforts and abilities of political rallying among the younger generation of science policy makers had results. In August 1961, the Norwegian government declined the invitation to take part in the launcher development project. The Swedish and Danish governments came to the same decision. In 1962, the European Launcher Development Organisation (ELDO) was established without the Scandinavian countries. A last-minute effort by the British government to persuade Norway to join ELDO led to new cabinet deliberations on the matter in March 1962. Cabinet deliberations revealed different points of view, but the government maintained the decision to turn down the British offer.

[15] Minutes from meeting at Ministry of Foreign Affairs, Oslo, 14.1.1961 (NTNF arch.).
[16] Report from the Norwegian delegation was submitted 15.2.1961 (copy in NTNF arch.).
[17] Norwegian Cabinet minutes 16.3.1961.

## Norway's preparation for ESRO, and sudden abstinence from membership

While the Blue Streak negotiations took place, preparations for the upcoming ESRO continued under the leadership of COPERS. Norway was very actively participating in these laborious preparations. In particular, Odd Dahl was extremely active as the Norwegian member of the Interim Scientific and Technical Working Group under COPERS and, later, as a member of the Launching Programme Advisory Committee.[18]

That Norway would join ESRO was taken for granted by the other COPERS members and by the small Norwegian 'space lobby'.[19] NTNF backed ESRO membership, but on one important condition: the expenditure on ESRO membership and the extra funding needed for a parallel expansion of national space research activities had to be financed by the government and not by, or at the expensive of, NTNF's budgets. This was also stressed in a long and thorough report submitted to government in February 1962, in which NTNF concluded with a highly conditional support of Norwegian membership in ESRO.[20] Despite the conditions, NTNF's Managing Director, Robert Major, sensed favourable reactions at a meeting with representatives from various ministries at the beginning of May 1962.[21] In fact, the Norwegian government started discussions concerning ESRO membership on favourable recommendations from the Ministry of Industry and the Ministry of Church and Education. Additionally, the Ministry of Foreign Affairs recommended that Norway sign the final ESRO convention at the forthcoming intergovernmental conference in Paris. However, there was last minute opposition from the Ministry of Finance which toppled the plans. In this situation, the government asked for advice from a group of representatives from NTNF, from the Ministry of Church and Education and from NDRE on what to do with a prospective ESRO membership. This advisory group unanimously concluded that the prerequisites needed for Norwegian participation were not in place.[22] With that, the outcome of government deliberations was given. Without discussion, the government concluded that at the present time Norway should abstain from participation in ESRO.

When the intergovernmental conference met in Paris on 14 June 1962 in order to sign the ESRO convention, the Norwegian plenipotentiary read a short statement formulated by the Ministry of Foreign Affairs in Oslo in which Norwegian membership in ESRO was refrained. The statement was quite unexpected amongst the other participants, and was met with consternation in the Danish and Swedish delegations.[23] After more than two years of intensive negotiations abroad and thorough deliberations at home, it was finally decided that Norway should stay out of the European space research cooperation. Gone were aspirations for Norwegian contributions to satellite development for ELDO, and the ambitions of playing an important part in ESRO's scientific programmes. Remaining was the national programme of space research – and the links with NASA and United States technology for Norwegian space experiments.

[18] Report dated March 1962, cf. letter from O. Dahl to R. Major 29.1.1962 (NTNF arch.). Letter from H. Massey to Odd Dahl 18.5.1962 (NTNF arch.). Letter from Odd Dahl to R Major 25.5.1962 (Ibid.).
[19] 'Notat om Den Europeiske Romforskningsorganisasjon (ESRO)', Ministry of Foreign Affairs 10.8.1961 (NTNF arch.).
[20] Note from the NTNF 'Uttalelse om norsk deltagelse i ESRO' dated 24.4.1962 (adopted at the Council meeting 26.2.1962, NTNF arch.).
[21] R. Major in letter to F. Lied 5.5.1962 (NTNF arch.).
[22] Report to Ministry of Foreign Affairs 9.6.1992 (NTNF arch.). Lied, Major and Leif Wilhelmsen were appointed members. Wilhelmsen was Director General at the Ministry of Church and Education and had previously argued strongly in favor of ESRO membership.
[23] Report from G. Heiberg to Ministry of Foreign Affairs (NTNF arch.).

## A National Space Policy Emerging Between Science and Technology

Norway's decision to stay out of ESRO was the result of the deliberations of a small scientific and political elite, which was neither convinced of the industrial benefits of ESRO nor of the necessity for Norwegian scientists to join the organisation. Nevertheless, only a short time after Norway's rejection of ESRO membership, new initiatives were undertaken to convince Norway to join the organisation. These initiatives were not based on scientific considerations, but on national interests in the areas of technology and industry.

As a result of the 1962 decision, NTNF's Space Research Committee was left with a programme concentrated solely on scientific research. The problem was securing Norwegian scientists' access to new technologies. The committee, still chaired by Odd Dahl, explained to NTNF that, in fact, a national programme for Norway outside ESRO would necessitate a substantially expanded budget. It would be necessary to continue the establishment of a satisfactory launch site at Andøya and to purchase sounding rockets. Extra funding for the research groups would be required for conducting experiments and training.

The first steps in this direction had already been taken, with the first sounding rocket launched from Andøya on 18 August 1962. This was financed through contributions from NTNF, from United States defence sources and through a very substantial contribution from NDRE's budgets. Although the first sounding rocket experiments were 'big science' at a low price, and the NTNF leadership was inclined to support space research, the field would absorb sums of a magnitude not readily funded from NTNF's strained budget. Moreover, the programme for space research now presented by the Space Research Committee confronted the space lobby within NTNF with important legitimation problems. Should programmes supporting basic geophysical research, and not the development of technology, be funded by NTNF at all?

Protests were raised in the NTNF Council and Executive Committee as the Space Research Committee's proposed programme for 1963 and 1964 was presented. These objections placed space research in a debate within NTNF concerning the aims and goals of the council, and in a debate at government level on the financing of research.[24] Space research still had the strong backing of the NTNF leadership, where Finn Lied's influence was increasing. In his view, scientific research had to be seen as a part of a wider programme of 'space activities', with space technology as the main focus. As a result, NTNF's Space Research Committee was dissolved in 1964 and replaced by a new permanent Committee for Space Activity. The new committee had two subcommittees: one for space research, and one for applications and industrialisation. It was organised in a way that underlined the new challenges that NTNF now expected in space-related fields. Advocates of space technology for telecommunication and Norwegian industrial interests were both represented on the committee, in line with the move within NTNF towards the 'utility' of research programmes.[25] The most striking aspect of the organisational changes made was that space scientists were removed from the top level advisory committee. They were even removed from the body formally responsible for the overall space budget within NTNF.[26] There was more at stake now than ionospheric physics. The use and development of space technology for purposes other than scientific research had gained importance. Scientific space research was still valuable, but only as one part of a wider activity of national importance.

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[24] J.P. Collett and H. Skoie, NOU 1981: 30B. Minutes from the NTNF Executive Committee meeting 27.2.1961. The Minister of Industry, Kjell Holler, was favourable to NTNF's line of argument. As a young man with fresh ideas, he was the youngest of all cabinet ministers, and as an economist he had been fascinated by the new prospects opened up by automation and new production technology. Remaining to be convinced, however, was the Ministry of Finance.

[25] The main committee consisted of four members: Ambassador Jens Boyesen, who was appointed Chairman, Finn Lied, Leif Larsen, Director General of the Norwegian Telecommunication Administration, and Bjarne Hurlen, who was Managing Director of the Kongsberg Vapenfabrikk, the state-owned arms factory. Finn Lied was on the committee as the only member representing an institution active in space research.

[26] With the new Committee for Space Activity, NTNF acquired a highly qualified diplomat as its chief representative in international negotiations concerning space. The choice of Boyesen was undoubtedly made at Finn Lied's instigation. Odd Dahl, on the other hand, did not get a seat on the main space committee, and instead was appointed Chairman of the Subcommittee for Space Research.

In accordance with NTNF's overall policy, in 1964 an expert group on space activity stressed industrial applications as the main reason for taking part in space activities. While in 1960 the first report on Norwegian space research concluded with a programme for scientific research with the help of sounding rockets, the 1964 report gave a strong recommendation for bringing Norwegian research and development into the era of satellites. The possibilities for taking part in satellite observations were decisive in the 1964 expert panel's recommendation that Norway should now reverse its policy and join ESRO as a full member. [27]

In the early 1960s, scientific activities related to space research were located at a handful of research institutions. In quantitative terms, NDRE was the most important. The Auroral Observatory in Tromsø was an important field station well equipped with measuring instruments, but its scientific staff was limited. Relatively small groups were active at the universities of Oslo and Bergen.[28] Both the Oslo and Bergen groups were quickly mobilised for the NTNF Space Research Committee's programme for experiments with the use of sounding rockets. Both groups also rapidly extended their scientific programmes into the development of scientific instruments for such experiments.

Instrumentation and science going hand-in-hand was to be one of the characteristics of the new field of space research, as had been the case during the formative years of Norwegian ionospheric physics in the mid-war years in Tromsø, and in the first post-war years at NDRE. The new age of space technology did offer a new challenge, however. The instruments now needed had to be constructed for reliable performance under extreme conditions and with no possibilities for readjustment. Consequently, the sounding rocket experiments demanded a new form of scientific cooperation, one in which participating groups had to work very closely together and to accept constraints imposed by the technology. Despite their institutional and geographical diversity, the small space research groups in Norway rapidly adapted to this working style.

## Andøya Rocket Range and the contest to establish an auroral launch site for ESRO

Agreements with NASA and the United States defence authorities had made sounding rockets available for Norwegian scientists. Occupying a central place in this cooperation was the rocket range at Andøya. The 1960 committee had been right when it assumed that a launch site in northern Norway, easily accessible in the auroral zone, would make Norway an attractive ally for foreign scientists. The drive that Finn Lied and NDRE had shown in establishing the rocket range had given Norway the advantage of an early start. Not until 1964 was the ESRO Convention formally put into effect, by which time Norway had two years' experience of launching sounding rockets from the *Andøya Rocket Range* (ARR), and Norwegian scientists and engineers had acquired important know-how through the NASA agreements.

But the planners of ARR were disappointed when the time came for a decision by the COPERS working group responsible for picking out a suitable launch site in the auroral zone. The choice was between Andøya and Kiruna (Sweden). The working group decided on Kiruna, finding that Andøya presented too many disadvantages. The choice of Sweden for the establishment of the ESRO launch site (Esrange) was undoubtedly a setback for Norway, for which this would have been an important investment. But the Swedish space research groups had an advantage in having started their planning and preparations for a

[27] NTNF's forskningsutredning, 1964, Bilag 18, pp.VI-VII.

[28] In 1960, Anders Omholt had been appointed research fellow connected with a new Oslo department of the Norwegian Institute for Cosmic Physics (NICP). This institute was the organisational umbrella put up in 1930 as responsible for the Auroral Observatory. Until 1960, the institute had also run a magnetic bureau in Bergen, which at that time was transferred to the University of Bergen. The Oslo department, which now replaced the Bergen department, served as an extension of Leiv Harang's research, and was located at Rosseland's Institute for Theoretical Astrophysics, where Harang also had his university office. Omholt had taken up research in photometrical studies of auroral light to supplement the radio-wave experiments undertaken by NDRE staff and the spectrographical methods developed by Vegard. At the University of Bergen, Professor Bjørn Trumpy led a group at the Department of Physics that for many years had carried out research in cosmic radiation and its relationship with solar activity.

launch site earlier than the Norwegians.[29] In addition, it was only to be expected that Esrange would be placed in Sweden since it did not hesitate to join ESRO. Andøya was also politically handicapped by its strong ties to the NATO military airbase adjacent to the launch site.

However, while the Kiruna range was still being discussed and planned, the small Andøya range, in its primitive way, was operational by 1962. The costly Esrange site at Kiruna would not to be operational for a long time after that. Funds for construction were not made available until ESRO was finally established, and the construction itself was to be time consuming. At the end of 1962, it was clear that launches could not take place from Esrange earlier than the autumn of 1965, and that this would be late for ESRO. COPERS was under pressure from scientists wanting to start their experiments, and at a COPERS meeting in February 1963, it was agreed that an alternative launch site had to be found.[30] A fact finding mission from COPERS went to Norway in March 1963 to see whether Andøya would be suitable as an interim launch site pending the completion of Esrange. The ESRO delegates were positive, and decided to apply to NTNF for permission to use the Andøya range for rocket launches. The projected launch campaigns were extensive.[31] The agreement with ESRO was finally signed in 1965 and the first six ESRO rockets and four CNES rockets were launched from Andøya in 1966. With this, Andøya was established as a relatively important launch site for auroral research. However, the extensive launch programme projected for ESRO was not realised. When Esrange at Kiruna became operational in 1966, ESRO launches were moved there.

Simultaneously, with overtures towards Norway on a practical and cooperative level, COPERS decided to invite Norway to participate in the further preparatory work for ESRO by sending observers to the plenary sessions of COPERS, as well as its working groups. This meant that Norwegian space researchers, although not members of ESRO, could maintain their scientific ties with research groups active in ESRO. Scientifically, ESRO came to follow an open strategy. Norway was not cut off from European scientific cooperation in space research.[32] Furthermore, Norway still had agreements with NASA[33], and it cooperated with its counterparts in Danish and Swedish space research.

## The ESRO telemetry station in Svalbard

Norway's position as a purveyor of service to the scientific programme under ESRO was to be considerably strengthened during the second half of the 1960s. The first important development in this direction concerned a satellite telemetry station that ESRO wanted to install in the Svalbard archipelageo.[34] Negotiations were brought to a successful conclusion in June 1965, when the Norwegian

[29] Report to the Interim Scientific and Technical Working Group of COPERS from the Subgroup for Scientific Projects 4.5.1961 (ESA archives, Florence, 61022). Bengt Hultquist, 'The start of space research in Sweden during the COPERS and early ESRO years, with personal recollections', in Arturo Russo (ed.): Science Beyond the Atmosphere: The History of Space Research in Europe, ESA HSR Special July 1993, pp. 91, 95-6. In fact, it was only in the summer of 1960 that a small group of Norwegian scientists travelled to northern Norway to explore possible range sites, and decided on Andøya.

[30] Letter from P. Auger, COPERS, to O. Dahl n.d. (March 1963). Also minutes from meeting in the NTNF Space Research Committee. 6.4.1963 (NSC arch.).

[31] At first, NTNF believed that the launches would be limited to one campaign of eight rockets in 1964. However, the agreement first proposed by ESRO comprised up to 24 launches in a total of four campaigns over two years. Later, the agreement was proposed to cover an even wider range of activities for eight years, with the possibility of renewal after that.

[32] Letter from P. Auger, COPERS, to Minister of Foreign Affairs 28.2.1963, response from Royal Norwegian Embassy in Paris to COPERS 11.6.1963 (copies in O. Dah1's papers, NSC arch.).

[33] Memo. of understanding signed 16.7.1964 (O. Dahl's papers, NSC arch.). The memorandum was signed almost a year after the first rocket was launched from Andøya. The status of the Danish laboratory had caused NASA administration some headaches. NASA would have preferred 'that the Danish cooperating agency be a national body equivalent to NASA or the Norwegian Space Committee' (letter from A.W. Frutkin to O. Dahl 28.1.1963, ibid.). A second memorandum of understanding between the NTNF's Space Committee and NASA was signed 5.8.1965, covering the firing of six Arcas and one Nike-Apache sounding rocket, aimed at the study of noctilucent clouds.

[34] In December 1963, Odd Dahl, as Chairman of the NTNF Space Research Committee, was approached by B. D. Lund, a Norwegian engineer working for COPERS, with a discreet inquiry about whether it would be possible to place one of the stations of the planned ESRO telemetry network on Svalbard. B.D. Lund, COPERS, in letter to O. Dahl 13.12.1963 (NSC arch.)

government signed an agreement allowing ESRO to enter a contract with NTNF concerning the establishment and operation of a satellite station at Ny-Ålesund on Spitsbergen.[35]

Establishing a telemetry station in this region posed several sizeable problems. The first were those connected with the building, maintaining and operating of a station under the extreme climatic conditions of the area. The second set of problems were those connected with the political sensitivity of any activity on Svalbard. These were linked to the clauses in the Svalbard Treaty of 1920, by which sovereignty over the territory had been granted to Norway. Thirdly, the developments in military technology after World War II and during the Cold War had contributed to making Svalbard a zone of the greatest concern for the strategic considerations of both the United States and the Soviet Union.

Due to the nature of Norway's relationship with the Soviet Union, and objections raised by Soviet authorities, an ESRO telemetry station on Svalbard presented a problem for the Norwegian government. The Soviets alleged that the ESRO station was, in fact, a camouflaged espionage centre, with the aim of serving NATO surveillance satellites and possibly also military air traffic. As a military establishment, this would be an infringement of the restrictions as laid out in the Svalbard Treaty. Norwegian authorities countered this argument by assuring the Soviets that the ESRO station was dedicated solely to peaceful scientific work, and that it could not be turned into espionage activities without important and highly visible alterations.[36]

Negotiations between ESRO and the Norwegian authorities became increasingly difficult over the location of the station. Two possible locations were mentioned by ESRO in their first correspondence: Longyearbyen and Ny-Ålesund. After inspections of both sites, ESRO decided on a location near Longyearbyen, a decision based on a cost and effort consideration. The Norwegian authorities wanted the station to be established at Ny-Ålesund, which was a more remote and inaccessible location. Behind the Norwegian wish were different political deliberations tied to strategic, economic and territorial interests.[37]

As negotiations over the location toughened, the Norwegian government tried to gain time by postponing its decision. Uneasiness over the political problems contributed to the government's hesitation. ESRO, however, pressed for a quick decision and threatened to build stations in northern Sweden and Canada instead. An agreement between ESRO and Norway was finally reached through a compromise in December 1964. The essence of the compromise was that ESRO consented to the station being placed at Kongsfjord in Ny-Ålesund on the condition that the Norwegians took on the responsibility of constructing and operating the station.[38] NTNF took on this responsibility.

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[35] The projected telemetry station was to be part of ESRO's range of satellite tracking stations, which had to be in place before the launch of the first ESRO satellite, scheduled for 1967. The first satellites were to be put in polar orbit. At the latitude desirable for a telemetry station near the North Pole, Svalbard clearly offered the best climatic and operational conditions. Royal decree 9.7.1965. Note from K. Holberg to F. Lied and R. Major 27.8.1964 (NTNF arch.)

[36] Memo from K. Holberg to F. Lied, R. Major and O. Dahl 27.8.1964 (NTNF arch.). Note from Ministry of Foreign Affairs, resumed in note by the Ministry 9.11.1964 (NTNF arch.).

[37] Report from visit to Spitzbergen 10-22.10.1964 from Mr. Hemre (ESA arch. 50587). Letter from Pierre Auger, ESRO, to Royal Norwegian Embassy, Paris 30.10.1964 (ESA arch. 50587). Telex from A.W. Lines to H.Kaltenecker 12.11.1964 (ESA arch. 50587). 'Notat om ESRO-stasjonens betydning for en norsk vitenskapelig virksomhet pa Svalbard', dated 30.11.1964, from Tore Gjelsvik, Norsk Polarinstitutt (NTNF arch.).Rolf Hanoa, Kings Bay Kull Comp. A/S 1917-1992. Fra gruvedrift til forskningsservice pa Svalbard, Oslo 1993, pp. 100-18. Willy Østreng, Det politiske Svalbard, Oslo 1975. Note to P. Auger from H. Kaltenecker, ESRO Headquarters, 13.10.1964 after meeting with Norwegian authorities 30.9.-1.10.1964 (ESA arch. 50587).

[38] Note 9.11.1964 from Ministry of Foreign Affairs (NTNF arch.). Information in this note was based on telephonic contact with B.D. Lund, ESRO. A telex from A.W. Lines, Technical Director, ESRO, to the Norwegian Ministry of Foreign Affairs 8.11.1964 officially confirming the threat of building a station in Sweden instead (ESA arch. file 50587) caused internal embarrassment in ESRO (note from J.A. Mussard to P. Auger 14.12.1964, ibid.).Cable from Ministry of Foreign Affairs, Oslo, to Royal Norwegian Embassy, Paris, 10.11.1964 (copy in ESA arch. 50587). Telex from A.W. Lines to H. Kaltenecker 12.11.1964 (ESA arch. 50587). K. Holberg, NDRE, suggested in memo. to R. Major 8.12.1964 that the Norwegian Telecommunication Administration should take over the responsibility for runnning the station (NSC arch.). Minutes from meeting of the committee for negotiations with ESRO on the telemetry station on Svalbard, 2.12.1964 (NTNF arch.).Formal contract between ESRO and Norway signed 21.9. 1965, between ESRO and Norway 30.8. 1965. 'Notat om behandlingen i Det interdepartementale Svalbardutvalg av spørsmalet om avtale og kontrakt med ESRO om telemetristasjon pa Svalbard', Ministry of Foreign Affairs 8.2.1965 (NTNF

As a result of the contract for the Kongsfjord Satellite Station at Ny-Ålesund, NTNF faced a completely new challenge as regards space activities. The first pioneering years of space activity under NTNF, with a rudimentary organisational framework, had come to an end. In this period, NDRE had assured the necessary support of infrastructure and personnel to allow Norwegian scientists access to sounding rocket technology. On Svalbard, there could be no question of letting a defence institution like NDRE take on permanent responsibilities. NTNF now had to establish a minimum of organisation of its own to take care of its obligations under the ESRO agreement.[39]

## Satellite development on a national, Scandinavian or international basis

Even inside the framework of scientific cooperation, space technology emerged as a field of wider importance to the nation than being primarily scientific. Scandinavian cooperation in the development and possible construction of scientific satellites had been Odd Dahl's grand idea when a possible membership in ELDO and ESRO were discussed. Under his chairmanship of the Space Research Committee, these plans were brought a stage further.

The drive to develop a Norwegian satellite in the mid-1960s was a scientific initiative, but it would be hasty to draw the conclusion that technological or even commercial considerations played no part in this. A 1964 report submitted to NTNF from the expert panel reviewing Norwegian space activity was very much a satellite project. When Norway took the decision to decline ESRO membership, the question of access to satellites for Norwegian scientists remained uncertain. Norwegian scientists had been invited to participate in the instrumentation of the first planned ESRO satellite, ESRO 1.[40] However, Norwegian scientists were anxious that these arrangements would not continue, and that the sort of 'backdoor activity' Norway was carrying out would be unacceptable and unfeasible in the future.[41] There was a need for different solutions as to what means Norwegian researchers could use to reach space. The project that the Norwegian scientists were considering was the construction of a small satellite of their own[42]. At the same time, a proposal for a Scandinavian satellite was presented to the Nordic space research community.[43] This project, as well as the Norwegian research satellite, was planned as a purely scientific project. The project for the Norwegian research satellite was also presented exclusively with scientific arguments.

The real advantage of Scandinavian cooperation in a satellite project would be the possibility of sharing costs. However, even in the first discussions among Scandinavian scientists it was clear that industrial policy was very much a part of the project. In order to obtain government funding for a satellite, governments had to be assured of its benefits to industry. This contributed to making international cooperative projects difficult. The Norwegians hesitated between a Scandinavian or a national option even though satellite enthusiasts in Norway already had their plans for a national satellite project, to be

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arch.). Memo. 8.12.1964 from K. Holberg to R. Major (Ministry of Foreign Affair arch. 72.2/42 A: Mappe Avtale med ESRO om telemetristasjon på Svalbard. Bind II). Minutes from the NTNF Council meeting 9.12.1964 (NTNF arch.)

[39] Cf. letter from the NTNF Commitee for Space Research to NTNF 12.1.1965 (O. Dahl's papers, NSC arch.). Minutes from the NTNF Council meetings, 9.12.1964, 23.2.1965 (NTNF arch.)

[40] Anders Omholt in interview 17.2.1995. Letter from B. Trumpy, University of Bergen, to the NTNF Subcommittee for Space Research 4.1.1965 (O. Dahl's papers, NSC arch.)

[41] The Subcommittee for Space Research voiced concern over this in its first five-year plan for space research, submitted to NTNF in August 1965. The NTNF Subcommittee for Space Research August 1965. 'Programme for norsk romforskning for årene 1966-70' (NTNF arch.)

[42] Suggestions for a satellite project. A proposal to the Norwegian Space Research Committee by O. Holt, T. Jæger, B. Landmark, B. Mæhlum (NDRE), E. Hesstvedt and A. Omholt (University of Oslo), A. Egeland (Norwegian Institute of Cosmic Physics).

[43] Swedish scientist Bengt Hultqvist suggested that the Scandinavian countries cooperate in the development of a small satellite to be launched by Scout. Bengt Hultqvist, 'P.M. om en skandinavisk Scoutsatellit', 30.4.1965 (O. Dahl's papers, NSC arch.)

launched in cooperation with NASA.[44] But NASA was not all go for launch concerning the Norwegian proposal. However, other United States sources encouraged Norwegian plans for a small satellite.[45]

The NTNF Subcommittee for Space Research was convinced that it was preferable to build a satellite of one's own than to participate in the development and instrumentation of satellites in cooperation with NASA or with other Scandinavian countries.[46] In its five-year plan for space research submitted to NTNF in the autumn of 1965, the subcommittee included a four-year project for the development of a Norwegian satellite. However, the satellite proposals from the Subcommittee for Space Research came to a sudden end. The project for an all-Norwegian satellite was abandoned due to budgetary constraints. It was deemed too large a project to be funded by NTNF's space research budget. Meanwhile, both the Swedish and the Danish participants in the Scandinavian space cooperation in SAR had expressed interest in continuing the satellite project at the Scandinavian level originally proposed by space scientist Bengt Hultqvist. However, it turned out that the three Scandinavian countries had different interests in the project concerning the expected industrial and scientific outcomes.[47]

## The real-time telemetry station in Tromsø

In addition to the proposed Norwegian satellite programme, the first five-year plan (1965) also contained another new project with the prospect of benefiting Norway both scientifically and technologically. This plan was for a real-time telemetry station to be built in Tromsø, and had the support of Norwegian space enthusiasts quite some time before the ESRO telemetry station on Svalbard was decided.

One particular advantage to real-time data downloading which proved tempting was the possibility of simultaneous observations by satellites and sounding rockets. For studying the aurora, this possibility was of great interest to both Norwegian ionosopheric physicists and their counterparts in ESRO. When the idea for a real-time telemetry station was introduced by Norway at the beginning of 1964, it was no coincidence that similar ideas were being discussed in ESRO.[48] The proposal for a real-time telemetry station was enthusiastically backed at the time by the Space Research Committee and its chairman, Odd Dahl. The committee recognised opportunities for Norway to enter into cooperation with satellite research groups internationally, and not just with ESRO.

Again, there was a race between Norway and Sweden to get the installations to serve the ESRO experiments, northern Sweden offering many of the same advantages as Tromsø as a location for a real-time telemetry station.[49] NTNF did not have the budgetary liberty to offer a real-time telemetry station to ESRO as early as hoped for. However, the flexibility of the Norwegian institutional arrangements emerged once again. NDRE decided to pursue the idea on its own and to install a small telemetry station in Tromsø, the equipment for which would partly be assured through support from United States and Canadian sources. Unlike the satellite project, the Tromsø telemetry station project received the wholehearted support of NDRE and Finn Lied.

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[44] Odd Dahl and Landmark went straight from the meeting where the Scandinavian satellite had first been discussed to the U.S. and a meeting with NASA to get support for their plans for a Norwegian satellite. Memo. 12.5.1965 SGP/AGO: pab: 'Norwegian Satellite Proposal' (NASA Historical Arch., File 6.20 Norway-US). Lorenza Sebesta, *US-European cooperation in space during the sixties*. ESA HSR-14, July 1994.

[45] The Norwegians were in touch with university professors whom had constructed similar satellites on their own. NTNF, Subcommittee for Space Research. Utvalg for forskning: Programme for norsk romforskning for årene 1966-67 (NTNF arch.) (Special reference is made to Professor B.J. O'Brien, Rice University). Memo. from K. Holberg to R. Major, F. Lied, O. Dahl and others dated 29.11.1965 (NTNF arch.). Holberg quotes Dr. R. B. Kershner, Supervisor, Space Development Division, Applied Physics Laboratory, Johns Hopkins University.

[46] The NTNF Programme for norsk romforskning for årene 1966-67: 9

[47] The problem with the Scandinavian satellite was the same as that with the Blue Streak project: there was no industry in Norway ready to follow the initiatives taken by the scientists. The situation in Sweden was very different.

[48] Bjørn Landmark was at the time engaged in work for ESRO and was a member of a working group under ESRO where the need for a real-time telemetry station in northern Scandinavia was under discussion.

[49] In November 1964, the ESRO Council decided that a real-time telemetry station should be made 'available, covering the northern European auroral zone.' The wording was carefully chosen not to upset the Swedes.

Norwegian ionospheric physicists – as well as their colleagues in other countries – saw opportunities for cooperation with the Canadians in the experiments on the Alouette satellites, which were carried out in close collaboration with NASA. The Norwegian initiative was met with enthusiasm by the Canadians and by NASA. Alouette II was to be placed in orbit by the end of 1965, and Canada and NASA went on with the International Satellite for Ionospheric Studies (ISIS) programme. NASA lent some of the necessary equipment in order to make the Tromsø station operational by the end of August 1966.

Before NDRE's telemetry station was finished, negotiations between NTNF and ESRO concerning cooperation in real-time telemetry had begun – NTNF deciding to establish its own telemetry station in Tromsø to serve both ESRO's and Norway's purposes. ESRO was in a hurry to have such a station operational by the launching of the ESRO 2 satellite, scheduled for the autumn of 1967. Subsequent negotiations ended in an agreement between ESRO and NTNF, which was approved by the Norwegian government in the summer of 1966. Strongly supported by the Space Research Committee, NTNF decided to give the Tromsø Telemetry Station priority as a project of national importance, and it eventually gained government approval.[50] As a result, the Auroral Observatory in Tromsø was changing from a field station for scientific measurements into a fully fledged research centre in the field of cosmic physics. As a scientific expansion, it was also seen as a part of a long-term project for creating a new university in Tromsø, as well as other regional and strategic considerations connected to the strengthening of northern Norway.

The real-time telemetry station was regarded by Norwegian authorities in science policy to be a golden opportunity for training Norwegian engineers in the use of PCM technology and digital computing. The development of the required computer equipment was to be an entirely Norwegian-driven technology development project, with NDRE as the leading institution.[51]. NDRE staff nurtured the vision of a Norwegian computer industry based on the type of digital computer that was delivered to the Tromsø station. The Tromsø contract was important for the further technical development of the computer, as well as a welcome contribution to the financing of the computer project at NDRE.[52]

The Tromsø Telemetry Station was the successful outcome of a national policy in the field of space research and technology, a policy comprising three elements. Firstly, there was the scientific aspect. Norway would create a niche in scientific research from which it would be able to benefit, even with few resources. The combination of satellite experiments and ground-based observations in the study of the aurora would be an extension and consolidation of the strength already acquired by Norwegian scientists. Secondly, it was a policy of keeping close contact with international cooperation in space research. Norway developed close ties to ESRO, without formally adhering to the organisation, by offering services based on her geographical advantages. Thirdly, there was an element of technological and industrial development. Norwegian research and industry were to gain technological know-how from deliveries to space service facilities in fields where they would be able to benefit from the contracts.

As a national policy, this was the result of a long process of internal Norwegian discussions. It was partly the result of strategic considerations and partly good luck. Whether or not it would last was considered uncertain by the NTNF Committee for Space Activity. ESRO, as a scientific organisation, had been open to the Norwegians, but for how much longer? In Europe, considerations of space technology were gaining attention, and international cooperation in the development of technology would undoubtedly impose

[50] After prolonged deliberations at ministerial and governmental level, mostly concerned with the economic risk that would be incurred by the Norwegian state if ESRO's use of the station turned out to yield less income than expected, the project was finally given government approval. Decisive in this outcome was that the project would be endorsed by other Norwegian interests, thus making financing possible. The Ministry of Church and Education was willing to finance parts of the station through grants to the Norwegian Institute for Cosmic Physics.

[51] NDRE's main interest in the telemetry equipment it now offered was that the digital computer be part of the equipment. NDRE wanted to deliver a computer of its own design and to buy the remaining equipment from the U.S.

[52] The computer project was in a decisive phase on its way to industrialisation. While the Tromsø project was under completion, four NDRE scientists, headed by Lars Monrad-Krohn, the leader of the Tromsø project, left NDRE and in 1967 formed the computer company Norsk Data. In the 1970s and 1980s this company emerged as a tremendously successful and profitable producer of minicomputers.

other constraints on the possibilities for non-Member States to participate. Such considerations led to proposals for the reversal of Norway's attitude towards ESRO as early as 1964.

## The second attempt at making Norway an ESRO member

When ESRO membership was again discussed in Norway in 1967, it was fully linked to considerations of technological and industrial development. In October 1967, at the instigation of the Committee for Space Activity, NTNF approached the government, advising a revision of Norway's attitude towards ESRO membership with the reasoning that developments pointed towards a reorganisation of European space cooperation in the near future. There was the prospect of a future merger of all the organisations, unifying space research, space technology and space applications into one organisation.[53]

NTNF cautiously asked the government to seek the advice of the different ministries and state agencies on what the attitude to European space cooperation should be, and whether or not to join ESRO. Despite interest expressed by the Norwegian Telecommunication Administration (NTA) and the Defence Chiefs of Staff to keep in touch with developments internationally, there was no endorsement of ESRO membership. The government also duly submitted NTNF's proposal for scrutiny by a new advisory body for science policy – the Central Committee of Norwegian Research – which submitted an assessment which de facto barred Norwegian ESRO membership.[54]

Arguments for joining ESRO were in one respect considerably weakened from 1962 to 1968. From a purely scientific point of view, ESRO membership appeared less important in 1968 than six years earlier. To the ionosphere physicists, ESRO membership had borne the promise of access to satellite experiments. As it turned out, ESRO's satellite programme had been very substantially reduced. Of the 17 satellites initially planned in ESRO's 'Blue Book' only six were launched during the first eight-year period until 1972. It was, after all, questionable how useful ESRO was for scientists.

Outside ESRO, Norway had been able to keep up and expand its scientific effort in space research. Recruitment of new scientists had allowed expansion, and so had increased funding from NAVF, NTNF and NDRE. Sounding rocket payloads launched from the Andøya Rocket Range were at the centre of Norwegian activity. Cooperation with other countries in sounding rocket experiments was extended to include the United Kingdom and the Federal Republic of Germany.[55] Development of the satellite stations in Ny-Ålesund and Tromsø considerably enlarged the scope of Norwegian space-related scientific activity, as did the expansion of scientific work at the Auroral Observatory in Tromsø. The establishment and operation of these institutions seized much of the financial and organisational capabilities of Norwegian science in general, but were important opportunities to build and procure installations and equipment.

The first pioneering era was over. Sounding rocket launches and satellite telemetry were gradually becoming routine work. Norway succeeded in actively participating in scientific cooperation with the ESRO Member States, as well as with the United States and Canada. Even without any financial contribution to ESRO, Norway was able to benefit from its geographical location to ensure a strong position vis-a-vis the organisation. Scientific research in space, however, was downplayed as part of the national space policy now emerging.

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[53] In 1963 ELDO and ESRO had been supplemented by a third European space organisation – CETS, the European Conference on Satellite Communication. In 1967, a European inter-governmental conference on space had recommended an integration of European space policy. This, in turn, meant that it could be harmful to stay out of ESRO as the most important of the existing European space organisations, the way the NTNF Committee for Space Activity saw it.

[54] Statement from Hovedkomiteen for norsk forskning in letter to Ministry of Foreign Affairs 14.2.1968 (NTNF arch.). Minutes from the NTNF Committee on Space Activity meeting 10.6.1967 (NTNF arch.). 121 Science and the policies of governments. The implications of science and technology for national and international affairs. OECD 1963

[55] Bjørn Landmark estimated in 1967 that in experimental ionospheric research, the Norwegian effort represented some 10 percent of total world activity.

## A National Programme for Industrialisation of Space Technology

The space lobby created in Norway had, in the mid-1960s, increasingly become an industrial lobby. Applications for space technology and the production of equipment by Norwegian firms had gradually taken over as the focus of NTNF's Committee for Space Activity. Industry, and not science, had become the central issue in the deliberations concerning Norwegian ESRO membership (1964-1965). From the mid-1960s to the late 1970s, the Norwegian space lobby worked to define a national space industry programme. The forging of this programme was to the greatest extent related to, and tangled up in, international developments, especially in the European arena. Deliberations in Norway about the benefits and/or deficits of ESRO membership evoked themes common to all European countries.

A major problem in Norway at the beginning of the 1960s was the lack of Norwegian industrial firms willing or qualified to take part in space technology development. This was not the case in other European countries where important industrial firms sought to benefit from the technological development under the ESRO programme. In fact, such industrial interests had been active in bringing about the formation of ELDO, ESRO and Eurospace.

The scientific programme of ESRO only indirectly contributed to the commercial exploitation of space technology through the design and construction of research satellites which yielded know-how and experience, also in other areas. The purpose that first materialised as a viable commercial use of space technology was telecommunication. However, when Britain proposed an independent satellite communication network, European development in the field of satellite communication was well behind the United States. Any satellite communication network to be operational in the foreseeable future would have to rely on United States technology. The European countries could, at best, aspire to participation in a United States-led cooperative effort, and tried to make preparations for a stronger negotiation position by forming the European Conference of Postal and Telecommunication Administration (CEPT) and the European Conference on Satellite Communication (CETS).

The Scandinavian Telecommunication Administrations were quick to react to upcoming satellite communication. The Swedes were first to raise the question and the Danish administration was leading the working group on satellites under CEPT. At the initiative of the Swedish Telecommunication Administration the directors of the Swedish, Danish and Norwegian administrations decided, in December 1961, to establish a Scandinavian Telecommunication Satellite Committee (STSK), the purpose of which was to start experiments with practical use of satellite communication. In 1963, the Scandinavian countries entered into an agreement with NASA assuring participation in United States satellite testing experiments. STSK had few economic resources at its disposal, but was given a free hand to initiate experimental projects in its field, the most important of which was the construction of an experimental ground station for receiving satellite signals. Such a ground station was built in Råö, Sweden and inaugurated in November 1964. NTA contributed 25 percent of the costs of the experiments and a Norwegian electrical engineer, Knut Melby, was appointed manager of the Råö station. In Norway, NDRE had already developed the capabilities to handle some of the technological challenges posed by the construction of the ground station.[56]

After the experiments at Råö were terminated in June 1967 and the station turned over to radio astronomers, Scandinavian cooperation in satellite communication continued and ultimately led to the establishment, in 1971, of an operational ground station serving the Intelsat network at Tanum, Sweden. This ground station brought no contracts for Scandinavian industry. The responsible Scandinavian authorities opted for minimum risk and minimum price and purchased equipment from established firms abroad.

[56] The system represented a continuation of similar equipment developed for weapons systems at NDRE. It integrated NDRE's expertise in servo-mechanical systems and in digital computers. The delivery to Råö was part of NDRE's buildup of capacity in design and construction of digital computers. As such, it was an important early step in the same direction as the digital computer delivered to Tromsø Telemetry Station in 1967.

Norway joined CETS from its beginnings, together with the Western European countries cooperating in CEPT. Together with its Scandinavian counterparts, NTA had been very quick to take up the challenge of using satellite communication as one of its long distance services. NTA was quickly convinced that satellites would be important for transoceanic telephone and television transmission, and was eager to ensure Norwegian access to the future Intelsat network. Norway signed the Washington agreement creating Intelsat in 1964 and, along with the other Scandinavian countries, in 1965 purchased users' rights at the British ground station Goonhilly Downs, thus ensuring telephone and television connections across the Atlantic via Intelsat.

NTA had been acting as a user of satellite communication technology and was quick to realise its possibilities. Membership in CETS and in Intelsat was essential for this. However, CETS had as its aim not only the harmonisation of European users' interests, but also the promotion of the development of European satellite technology. This part of CETS's programme had been attracting the NTNF space lobby that was hoping for industrial development in Norway. The 1964 expert report to NTNF on space research had pointed to CETS, besides ESRO, as a centre of development of space technology where Norwegian industry would have much to gain from Norwegian participation.[57]

CETS proved to be somewhat ineffective in getting things done in satellite technology. Nevertheless, it was the organisation which first brought about Norwegian participation in the development of space segment technology related to satellite communication and passed the first industrial space contract to a Norwegian firm. This was through the programme for telecommunication experiments using the projected ELDO F-9 test satellite.

## The first space project for Norwegian industry: The F-9 test satellite

A Scandinavian working group was organised in December 1965 to investigate the possibility of a Scandinavian consortium to implement part of the F-9 experiment. The initiative was taken by the telecommunication administrations of the three countries – which were the national contacts with the CETS Technical Planning Staff responsible for the project – although the group comprised people from research institutions and industry. The group proposed a Scandinavian consortium to take responsibility for the experiment, with NDRE as the Norwegian participant.[58]

The F-9 project materialised at the time when plans for a Norwegian or Scandinavian scientific satellite, mentioned earlier, were brought to an end. When the F-9 project was discussed in NTNF in 1966, it was presented as a project for the industrialisation of space technology in Norway. The same year, the Subcommittee for Industrialisation and Applications under NTNF's Committee for Space Activity was established. The F-9 project became the subcommittee's first case.

As had been clear with the projected Scandinavian research satellite, the conditions for industrialisation of space technology in Denmark, Norway and Sweden differed widely. This also became clear with the F-9 project. In Norway, there were no industrial interests willing to endorse the project nor was there any funding for it. After some time, an industrial partner was found in the state-owned *Kongsberg Våpenfabrikk* (KV).[59] KV was interested in the F-9 project as an extension of activities the firm had begun under its military contracts.[60] The three participating Scandinavian countries, joined by Belgium, took on responsibility for the design and construction of a complete solid-state test transponder to be flown on the satellite, together with a telemetry transmitter and encoder giving information on the performance of the equipment on board. The equipment to be developed at NDRE and KV was the telemetry pulse code modulation encoder to be used for the two test transponders on the satellite.

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[57] NTNF's forskningsutredning 1964. Bilag 18. Romforskning, pp. 34-5.
[58] The Norwegian member was Karl Holberg of NDRE.
[59] Translating to: Kongsberg Weapons factory.
[60] However, KV was not willing to cover any more than a small part of the costs of the F-9 project, and was dependent on technical assistance from NDRE in systems design. At the time, KV was extremely busy with the Penguin project and had limited resources to devote to the F-9.

The F-9 project itself bore the stamp of what had, in some measure, become the Norwegian favourite approach to space: the F-9 experimenters were offered a free ride on a satellite paid by others. It was an opportunity that could not be missed. It was also the first industrial project related to space to be presented to NTNF. With the assistance of NDRE and NTNF's Centre for Industrial Research (SI), KV succeeded in designing and assembling the telemetry encoder on a very tight time schedule. The complete transponder was successfully integrated, and the Scandinavian-Belgian cooperation went smoothly. In the development of space equipment, the Scandinavian-Belgian F-9 project was successful.

Politically, however, the project had been more problematic. It had taken time and effort to form the consortia, and to ensure the necessary agreements for carrying out the experiments. Also, Norway's participation in the project had been resented by Italy.[61] The political problems were eventually sorted out; however, the launching of the satellite on 12 June 1970 failed, as had all the previous launches of the Europa-1 rocket. The Norwegian effort in the technology development was nevertheless regarded as a success by Norwegian science policy makers, but as an attempt at the industrialisation of satellite technology in Norway, the F-9 project was not followed up, neither by the KV nor by any other Norwegian firm. It was the first time a Norwegian firm aimed at the 'space segment' of satellite technology, and it took many years before it was repeated.

## The search for a space industry programme and new trends in national industrial policy

In the mid-1960s, there was globally a lack of commercial markets for space technology. When various experts, as advisors to NTNF, urged that Norway go into satellite technology development, their proposals invariably entailed membership in different international consortia. The optimistic project for an all-Norwegian satellite in 1965 was the only exception. Increased technical sophistication and the spiralling costs of satellites put an end to these types of 'kitchen table' satellites. Norwegian participation in satellite technology had to be in the form of international space cooperation.

Through CETS, the only European space organisation of which Norway was a member, Norway had gained access to the F-9 telecommunication experiment. As a member of Intelsat, Norway was also invited to tender bidding on minor components of Comsat equipment. However, Norwegian firms had shown little interest. As a member of CETS, Norway was likely to be invited to take part in a large telecommunication satellite development programme. But in the final days of December 1967, both NTA and the Ministry of Transport and Communication rejected the opportunity.[62]

With the Subcommittee for Applications and Industrialisation of Space Technology appointed in 1966, NTNF created an instrument for the definition of a national programme. But what elements should such a programme comprise, and who was to take responsibility for its coming to fruition and for its funding? In what fields could Norwegian industry expect to be competitive? There was general agreement between the two committees on the need for specialisation and for a clear direction of national policy.[63]

Discussions in the Committee for Space Activity pointed to the fact that a national industrial space programme would need ways of coordinating the nation's technological, political and industrial efforts which were not characteristic of the Norwegian society. The shift in government attitude towards research as a tool for industrial growth had started during Kjell Holler's term of office as Minister of Industry. For Norwegian politicians and administrators, electronics bore the promise of a fast growing industry and, as a key sector of industry, it was assumed that it would open up a wide range of applications.

NTNF had been quick to follow up on the growing interest in research policy at government level. In 1963, NTNF started a comprehensive review of its research effort, summarised in a report submitted to

[61] Minutes from the NTNF Committee for Space Activity meeting 1.11. 1967 (NSC arch.)
[62] Minutes from the NTNF Committee for Space Activity meeting 1.11.1967 (NSC arch.). 41 Minutes from the NTNF Committee for Space Activity meeting 18.11.1967 (NSC arch.). 42 Letter from Ministry of Transport to Ministry of Foreign Affairs 27.12.1967 (NSC arch.).
[63] Minutes from meeting in the NTNF Committee for Space Activity 1.11.1967 (NSC arch.)

the government in 1964. The essence of NTNF's proposals to government was that research should be seen as an integral part of a national industrial policy, much in line with the OECD proposals of the early 1960s. By initiating a national programme of industrialisation of space research, NTNF's Committee for Space Activity put on its agenda the full set of problems related to the proposed new division of responsibility between state and industry. A coordinated and focused national programme had been urged, but who was to take the lead? NTA had long been under pressure to take on responsibility for the development of new technology, supporting an electronics industry in Norway, and to establish a department for basic research. However, the most important players behind this were to be found at NDRE.[64]

NDRE's efforts to persuade NTA to start doing research were part of a larger strategy and connected to the efforts to modernise Norwegian industry. The beginning of the 1960s marked an upgrading of NDRE's ambitions. Activity was concentrated at Kjeller, just outside Oslo. Under Finn Lied's and Karl Holberg's leadership, NDRE embarked on the extensive Penguin missile project.[65]

Weapons and communication technologies were the two fields to be given priority by NDRE. Both had connections with space technology. Experience with space technology would yield important spinoffs. Space and telecommunication technologies were converging on satellite communication. They would all benefit from the widening of Norway's base of knowledge and experience in electronics. Conversely, NDRE needed partners in its plans for ambitious electronics projects. NDRE alone could not provide the necessary support for national research and industrial activity on the scale necessary to make the projects possible. In this context, NTA stood out as NDRE's most obvious partner as a co-sponsor of a research-based electronics industry. NTA represented the largest domestic market for electronics equipment.

In a turbulent time for European space cooperation (1967-1968), it was far from clear whether the CETS project would be carried out at all. A Scandinavian option was one possible alternative. In 1967, Sweden started discussing plans for a Swedish or Scandinavian telecommunication satellite. The Swedish project was in line with similar projects in many European countries and aimed at supporting domestic industry. The Danes and the Norwegians would possibly be offered stakes in it in order to share costs and risks. When the prospects for a European telecommunication satellite seemed less feasible, Karl Holberg, in 1968, recommended that Norway join the Swedish satellite project. This would mean that two years after the NTNF leadership had rejected the projected Scandinavian research satellite in 1966, it would be invited to endorse a Scandinavian telecommunication satellite after all.[66]

## Maritime satellite communication as an answer to the need for a direction in space policy

Without Norway's participation in a telecommunication satellite project, NTNF's Committee for Space Activity was still without a national programme for the industrialisation of space technology. In this respect, 1968 was a decisive turning point. It saw the emergence of a field in which Norway was to follow a successful industrialisation plan for the years ahead, namely maritime communication.

It was also a year of change in personnel related to space research within NTNF. The organisational changes undertaken – carefully stage-managed by Finn Lied – strongly set out in the direction of defining telecommunication as the chief priority of the Norwegian space effort. Space scientists were still confined to a modest position in the organisation, while the men taking over at the top were communication experts.

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[64] John Peter Collett and Bjørn Lossius, *Visjon, forskning, virkelighet. Televerkets Forskningsinstitutt 25 år*. Kjeller 1993.

[65] This project was a synthesis of many fields in which the NDRE staff had acquired skills, ranging from rocketry to digital computers. Moreover, given its ambitions, the Penguin project depended on a massive widening of NDRE's skills and, also, the mobilisation of a scientific and industrial environment for support. Absorbing a total of 1,000 man-labour years during its first phase up to 1970, Penguin was the largest technology development project ever to be undertaken in Norway. Its size and its scope were signs that the NDRE researchers no longer were content with copying technological development abroad. The aim now was to 'leap-frog' into the technology of the future.

[66] The Scandinavian project had an estimated total cost of NOK 120 million over four years. With a Norwegian stake of about 30 percent, the annual cost would be NOK 7.5 million or about the same as Norway would have to pay for participation in a possibly reorganised ESRO.

The identification of maritime communication as the focus of Norwegian industrialisation of space technology was a process that had started before the changes within NTNF, first and foremost at ELAB – a laboratory for electronics established as an extension to the Norwegian Institute of Technology – in its work on technology for satellite communication.[67]

The choice of maritime satellite communication could be strongly defended from Norway's position as an important shipping nation. In the late 1960s, the Norwegian merchant fleet represented 10 percent of the world tonnage. In no other field could there be found a domestic Norwegian market of the same relative importance. In addition, Norwegian firms held an important position in the market for ships' communication equipment, which had long been a speciality of Norwegian radio producers, among them NERA and *Elektrisk Bureau A/S* (EB), a subsidiary of the Swedish Ericsson corporation. The sales of each of these two companies represented some 15 percent of the world market for large ship radio stations.

Norway had the ideal conditions for this industry: a large potential market, strong industrial interests in the field, an interested research centre mastering advanced technology and a government agency willing to endorse the project. However, the history of the maritime satellite communication project has been one of ups and downs, where success was assured only through the laborious efforts of the various participating parties. A field like maritime satellite communication was well suited for the sort of industrial policy that NTR wanted to undertake and which it was applauding. The field was, in itself, new and without already-established manufacturing companies. The technology was challenging and in the absolute forefront of telecommunication.

Maritime satellite communication would eventually prove to be a Norwegian success story. NTA became one of the largest participants in the Inmarsat consortium formed in 1979 to operate a worldwide maritime satellite communication system. The Norwegian firm NERA became a world leader in the deliveries of ship terminals and ground stations for the system, after having first won the tender bidding for a systems study of maritime communication under a contract with NTR in 1969.

NERA, together with another Norwegian firm in maritime electronics, SIMRAD A/S, concluded that Norway should start the development of ship terminal equipment as a general investment in the future, when further technological development would make maritime satellite communication possible.[68] The report confronted the Norwegian space lobby with a dilemma: should Norway embark on a high-risk development programme in a field where nothing was secure, or should the country opt for a more cautious wait-and-see policy? The small group of people in the decision making bodies were of different minds.[69] Additionally, the optimism in the 1969 systems study found little resonance among the prospective users, the ship owners, who received the report with great scepticism. In their opinion, the estimated demand for ship-to-shore communication was greatly exaggerated, and they were not readily convinced by arguments for satellite communication based on assumptions of increased need for communication as a result of the changing structure of the shipping industry itself.[70]

Due to uncertainties for the requirements of, or prices for, maritime satellite communication, by 1971 the project was almost terminated. There was no agreement internationally on what sort of technology should be used, nor was there endorsement by the prospective users of the communication system. Finally, there was great bewilderment in Norway as to where developments should be pursued, but eventually the work was continued. It was agreed that a development contract for the construction of a complete test ship

[67] ELAB – Elektronikklaboratoriet.
[68] Maritim satellittkommunikasjon. En systemstudie utført av A/S Nera og SIMRAD, 1969 (NSC arch.).
[69] Bjørn Rørholt, as chairman of the NTNF's Committee for Space Activity, recommended the cautious alternative. Reporting from a visit to the U.S. in 1970, he concluded that a future global satellite system for maritime communication was, at best, still in an uncertain future.
[70] Two structural changes had been foreseen: First, an increased need for the owner to instruct and supervise the day-to-day operation of the ship. Second, a development towards automation on board which would entail the need for data transmission between owner and ship, which could not be handled satisfactorily by the existing radio system.

terminal should be opened for bidding by Norwegian firms. Moreover, this was a decision in favour of the most advanced and most radical technology.[71]

The tender bidding for the ship terminal contract at first ended in failure. Eleven Norwegian firms who had joined Eurospace and formed a Norwegian 'Eurospace group' (amongst them KV, NERA, SIMRAD and EB) sent NTNF a letter making it clear that they found it premature to start on an industrial development of equipment, without government assuring the financing, and without a clear coordination with international projects.[72] The satellite enthusiasts at NTR and in the NTNF subcommittee suffered a serious setback. However, they did not give up. A renewed project for an experimental ship terminal – Marsat Phase 1 – was presented in 1972, with a slightly different approach to an industrial solution in the form of one single consortium.[73]

The end of 1972, had two consortia NERA/SIMRAD and STK/EB actively competing for the contract with NTNF for the development of a ship terminal. NTNF's Committee for Space Activity decided to award the contract to NERA/SIMRAD, despite the comparatively small resources the two firms were able to put into the project. The award to NERA/SIMRAD for the Marsat Phase 1 project represented a choice for a research-led, rather than industrial capacity, alternative.[74]

## Marots, Marisat and Inmarsat

Internationally, the situation for maritime satellite communication had, by 1973, radically changed in comparison with the fundamental uncertainty prevalent only two years earlier. Moves were underway in a number of different international fora towards the establishment of an operational system for this technology.[75] At the end of July 1973, the European Space Conference (ESC) decided that ESRO should undertake the development of a maritime communication satellite system, Marots. This was part of the 'package deal' that paved the way for ESRO to expand into a new, single European space organisation, ESA.

Originally, Marots was a British-led maritime satellite project, only later to be proposed as part of the second package deal. The decision for Marots to become one of the optional programmes under ESA led to a renewed examination of Norway's attitude towards European space cooperation. By 1973, Norwegian authorities initiated a new debate on ESRO/ESA membership. The outcome was a decision not to join the new organisation, but to participate in the Marots programme.

International developments confronted Norway with new challenges. The programme that had been defined in Norway was easily compatible with the Marots concept. But with the advent of the US proposal for a competing Marisat system, Norwegian industry was facing a commercial challenge and not just a technological one. Marisat would become operational well ahead of the projected Marots. To go on developing equipment for Marots alone was considered to be a great commercial risk.[76] Commercial

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[71] While the Nera/SIMRAD systems study had been sceptical towards the use of ELAB's electronically steered phased array antenna, it was now decided that this technology should be at the basis.

[72] Only a few firms had shown interest in the tender bidding, among them Nera/SIMRAD and *Standard Telefon og Kabelfabrik* (STK) A/S, the subsidiary of ITT. None was willing to commit itself to a ship terminal project without the full economic backing of the state. NTNF had been prepared to give some support, and felt deceived that no firm found the project interesting from a commercial point of view.

[73] With some surprise, the other two firms interested in the project, STK and EB, decided to form a consortium to make a bid for the contract. STK wanted to become an innovative electronics firm and sought both NTR and NDRE as sources for new technology and new ideas.

[74] Nera and SIMRAD had limited possibilities for independent equipment development. They had few economic resources to put into the project, and they were unable to foresee a market strategy for the equipment. They became junior partners in a project led by ELAB.

[75] The Intergovernmental Maritime Consultative Organisation (IMCO) had started studying the possibility of satellite communication and had begun discussion on a global system. Frequencies for maritime satellite communication were allotted by the World Administrative Radio Conference (WARC), the ITU body responsible for the regulation of radio communication, in 1971. Also in 1971, ESRO established a maritime advisory group, which had initiated preparatory studies similar to those undertaken in Norway.

[76] Interview with Arne Sagen 2.11.1989

considerations were decisive for the strategy of industrialisation that was ensuing in Norway. The decision was not taken, this time, by the NTNF committees, but by industry itself.

With the oil price shock in 1973, the shipping industry was thrown into worldwide crisis. Norwegian shipping, with oil tankers as a very large part of its fleet, was severely hit. The crisis brought forth structural changes in the Norwegian ship electronics industry. One result of these changes was that the long-standing competitors, NERA and the EB, in 1974 decided to join forces and form a jointly owned firm – United Marine Electronics (UME) – for the production and marketing of ship communication equipment.[77] The question arose whether a ship terminal should be designed according to Marots or Marisat specifications. The decision was made to drop the technology development for the ESA system since Marisat had the advantage that it was already defined and would be operational at a given date; it was not an experimental system. Commercial operations of Marisat began in the summer of 1976. By 1978, the first ship terminal from EB (the company had by then acquired NERA and UME) was on the market.[78]

The International Maritime Satellite Organisation (Inmarsat) was established to own and operate a global communication system for merchant shipping, with 40 countries as initial investors; five countries were major investors. Norway was the fourth largest investor in Inmarsat, with a share equivalent to its proportion of the world merchant fleet.[79] NTA had been very active in the negotiations leading up to the formation of Inmarsat and was the Norwegian authority responsible for Inmarsat membership. Through Inmarsat, NTA was able to furnish Norwegian ship owners with global coverage of ship-to-shore and ship-to-ship communication via satellite. Satellite communication rates were changed in a way to attract more users and a growing demand for satellite communication made NTA's investment in Inmarsat profitable. Through the Inmarsat consortium, NTA's negotiators were able to assure that a ground station for the system was placed in Norway. In February 1982, NTA opened its Inmarsat ground station at Eik in Rogaland, covering communication from Europe to ships in the Indian Ocean. At that time, about 100 Norwegian ships were carrying ship stations.[80] The equipment for the ground station was delivered by Norwegian industry and research institutes. EB's NERA division was chosen as the prime contractor, with NTR, ELAB and NDRE providing support. With this early start, NERA (from 1994 onwards again an independent company) was able to carve out a niche in the market for subsequent ground stations for the Inmarsat system.

Maritime satellite communication as a Norwegian specialty was conceptualised by researchers. What made the idea come to fruition is that it was sustained by other groups and became a part of space technology development in which Norway aspired to play a major role. This was not only due to the fact that Norway was a large shipping nation with important users' interests, but it was also at least just as much a result of the creation of a space lobby in Norwegian society that was able to define a programme and rally support for it.

[77] The establishment of the joint venture was the first step towards a merger; in 1977 EB took over Nera. After having been taken over by the Swedish-Swiss ABB conglomerate, EB and Nera were again separated. From 1994, Nera A/S was an independent company and represented the continuation of satellite developments of Nera, EB and UME. EB had left the circumstantial alliance with STK when the contract for MARSAT was awarded Nera and SIMRAD.

[78] This was the first generation of the Saturn ship station. The EB was the first European firm to offer a ship satellite station, and the Saturn station became the greatest commercial success of any space product developed by a Norwegian firm. Including subsequent generations of updated equipment and a land-mobile version, some 9100 Saturn stations were delivered between 1978 and 1995.

[79] The Inmarsat convention became operational in 1979. U.S. held a 17 percent share, the United Kingdom 12 percent, the Soviet Union 11 percent, Norway 9.45 percent and Japan 8.45 percent.

[80] In the first year of operation, the volume of traffic through the Eik station brought gross revenues to NTA of NOK 4 million a month.

## Norway's Long Road to ESA Membership

During the first part of the 1970s, Norway's general relationship with Europe became the central theme of Norwegian foreign policy debate.[81] In the case of space activity, the European question – in this case, whether or not to join ESRO/ESA – also came to be the focal point of discussion. It proved to be impossible to discuss Norway's policy in space without it being related to space cooperation in Europe. Compared with the 1960s, the range of participants in the Norwegian space policy debate was substantially greater. The expansion of space activity during the 1960s had now gained momentum in Norwegian society. Decision making thus implied a wider spectrum of societal interests, while at the same time, the foreign policy implications of Norway's relationship with Europe in space was gaining in importance.

Consequently, the way in which space policy was shaped in the period from 1970 to 1987 vis-à-vis Norway's international relations, is a complex story. It concerns scientific development, industrial policy, security and allegiance policy and – with the advent of direct broadcasting satellites – cultural policy, to mention just a few important dimensions.

### Norwegian space research in the early 1970s

Scientific space research had been the point of departure for Norwegian space activity, gaining momentum throughout the 1960s.[82] The consequences of abstaining from ESRO membership had not been too harmful to Norwegian cosmic geophysics research. The Norwegians were invited to fly their instruments on board the first ESRO satellites and they were very active in international cooperation in sounding rocket experiments. Also, the ground-based observation facilities were expanded to ensure the availability of high quality observation data to Norwegian scientists, who far from being cut off from international developments in cosmic geophysics, enjoyed continued international recognition for their work.

At the centre of Norwegian scientific efforts was still the sounding rocket activity at the Andøya Rocket Range, and at the Tromsø Telemetry Station and Auroral Observatory. With the installations at Andøya and Tromsø, Norway was equipped with unique instrumentation for carrying out space research in the auroral zone. In spite of the competition from ESRO's launch site, Esrange in Kiruna, the Andøya Rocket Range was extensively used for sounding rocket campaigns for both bi- and multilateral projects. Up to 1972, after ten years of operation, a total of 104 launches had taken place at Andøya. Practically all of the experiments had been in cooperation with foreign scientists; only two sounding rockets involved no outside participation. By the early 1970s, the initially rather primitive launch site, was substantially extended.[83]

The sounding rocket experiments were an extremely efficient way for Norwegian space scientists to gain access to international scientific cooperation and for providing funding for their work. Foreign contributions to sounding rocket launches were subsidising the research groups. Despite research funds from NTNF remaining at a constant level, foreign revenues had allowed for a substantial expansion of national scientific activity, and the cooperative experiments provided measurement results for Norwegian scientists which they would otherwise have had to obtain at their own cost. Although these arrangements were advantageous for Norwegian scientists, they did demand a certain working style, one which necessitated the acquisition of cooperative projects by keeping in constant contact with their foreign counterparts.

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[81] The Storting decided to apply for EEC; membership in 1970, but in a 1972 referendum, the electorate voted against. Far from settling the European question in Norway's foreign policy, however, the 1972 'no' to EEC was, in fact, the start of a long process in which Norway gradually became more and more integrated in the European circle.

[82] By 1972, the group of physicists working on ionospheric research in Norway had grown to about 35 people.

[83] In 1969, NTNF decided on a programme upgrading the range, representing an investment of NOK 4.5 million, equalling more than the total amount invested at Andøya since its start in 1962. The investments comprised both an upgrading of the technical equipment to maintain par with the development of sounding rocket technology, especially in telemetry, and an extension of the buildings to make the station more convenient for users staying for prolonged campaigns.

When it was decided, in 1969, to upgrade the Andøya Rocket Range, negotiations were already underway with potential foreign users, especially scientists in the United Kingdom and the Federal Republic of Germany, who were interested in using Andøya for their campaigns. However, the relationship with Esrange in Kiruna became a matter of political delicacy when the ESRO Council, in December 1971, decided that sounding rocket activity at Esrange would no longer be part of their programme, thus implying that ESRO would discontinue its responsibility for Esrange.[84]

After complicated negotiations between the Swedish Space Corporation, NDRE, the NTNF Space Activity Division and ESRO, the Esrange Special Project (ESP) was established and included the Andøya Rocket Range.[85] Under this arrangement, the ESRO Member States would have access to Esrange and Andøya. It was acknowledged that the two launch sites supplemented each other; Andøya being better suited for certain experiments than Esrange. The ESP was initially agreed for a five-year period (up to 1977), but was later extended by new agreements. The arrangement led to greatly increased activity at Andøya and made it possible to continuously extend the range equipment necessary for launching new types of sounding rockets and for mastering new techniques.

As a vehicle for carrying out space research experiments, the sounding rocket held its position vis-à-vis satellites. Sounding rockets remained a cornerstone of the NASA International Cooperative Programmes, and NASA continued to provide rocket motors and rocket hardware for launches in cooperation with other countries. Andøya became one of the most frequently used launch sites under the NASA international programme.[86] The range ensured Norwegian geophysicists access to close cooperation within the Atlantic circle. In particular, NDRE's activity from the early 1960s with the aim of achieving close contact with NASA, had been fruitful. The relationships developed between Norwegian researchers and their counterparts in United States research institutions and in NASA, allowed for swift and flexible arrangements for cooperative sounding rocket experiments.

Without making economic contributions to ESRO, Norway had thus far managed to maintain a firm position in scientific cooperation and to profit from the provision of services. However, in the early 1970s there was some uneasiness about the future due to the closing of the Kongsfjord Satellite Station foreseen by 1974.[87] There was also apprehension about the future possibilities for Norwegian space research, and that non-membership in ESRO might prove detrimental in the years to come.[88]

A proposal to establish a grand project for Norwegian space science emerged from the need to take care of national resources and groups. The proposal was a European cooperative project for the construction of an incoherent scatter facility in the auroral zone. The suggestion that Norway should participate in the European Incoherent Scatter facility (EISCAT) was presented in 1972. The project planned to include several large technical installations in northern Scandinavia. The central installation, the transmitter with a giant antenna, was to be placed near Tromsø, with receivers in Tromsø, Kiruna and Sodankylä (Finland). Compared with the fairly modest installations that were then in existence at Tromsø and Andøya, the EISCAT project was of huge dimensions.[89] This new scientific installation was of great

[84] On 1 July 1972, Esrange was transferred to Sweden. ESRO's decision was part of the process going on at the European level, turning ESRO more into the field of space applications. It was agreed that sounding rocket experiments could be taken care of under various national research programmes.

[85] Fredrik Engström and Klas Änggard represented the Swedish Space Corporation, Bjørn Landmark, the NDRE, Arne Gundersen, the NTNF Space Activity Division, and Hans Kaltenecker, ESRO

[86] Up to 1975, 43 sounding rockets had been launched from Andøya in cooperation with NASA, representing nearly 10 percent of the sounding rockets launched outside North America. This had made Andøya one of the most frequently used launch sites for NASA outside the American continent.

[87] The Kongsfjord Satellite Station was being run on a seven-year contract with ESRO, which was extended until it closed down in September 1974, when the ESRO satellites TD-1 and ESRO IV ceased to function.

[88] This was the conclusion of a 1973 NAVF committee.

[89] Several factors contributed to making EISCAT appealing to Norwegian scientists. A Norwegian scientist, Tor Hagfors, was one of the driving forces behind the EISCAT proposal. He had been engaged in ionospheric research at NDRE and had later moved to the U.S., where he had taken part in the development of the incoherent scatter technique. Apart from giving Norwegian researchers access to new equipment in the forefront of science and technology, EISCAT would contribute greatly to extending the milieu for cosmic geophysics that was localised in Tromsø.

importance to not only the science political concerns on a national basis, but also as a tool for regional strengthening, as was the case with the new university in Tromsø.[90]

Space science and space technology applications for commercial ends had both been seen as parts of NTNF's responsibility for 'space activity', as defined in NTNF in the early 1960s. By 1970, it had become evident that this construct was disintegrating, NTNF having turned its attention more in the direction of applications. The expansion of university research in space-related disciplines – which had been encouraged by NTNF and NDRE – now brought demands on new instrumentation and new funding that NTNF was unable or unwilling to satisfy. That NAVF was willing to endorse the EISCAT project and to provide Norwegian geophysicists with very important new ground-based observation instruments, was a breakthrough for geophysics as an academic discipline in Norway. The Norwegian development was in line with parallel development in Europe. As ESRO became increasingly focussed on space applications, academic scientists had to look for funding and equipment from other sources. National scientific programmes and international arrangements outside of ESRO – such as EISCAT – became more important.

## Norwegian space science in Europe and America

In the case of EISCAT, uneasiness among Norwegian space scientists led to Norway's adherence to a new European cooperative scientific organisation outside ESRO. When steps had been taken for a renewed approach to cooperation under ESRO, scientific research was not central. The developments going on in Europe had their focus on space technology applications. However, it is a paradox that the decision in Norway not to join ESRO/ESA this time was based on considerations concerning science.

The Ministry of Foreign Affairs closely followed the complicated and difficult negotiations going on in Europe from 1968 onwards. The initiatives for a renewed examination of Norway's attitude towards European space cooperation were all taken by this Ministry. These included plans for involvement in the projected telecommunication satellite, ECS.

Even without the support of important national institutions like NTA and the National Broadcasting Corporation or Norway (NRK), the Ministry of Foreign Affairs was able to obtain government approval for joining the refurbished European telecommunication satellite project in the early 1970s, on the condition that it was joined by all CETS members. This represented a breakthrough for Norwegian participation in European space cooperation.[91] The Ministry of Foreign Affairs was simultaneously preparing a white paper on European space cooperation to be presented to the Storting in the autumn of 1970, obviously aimed at getting parliamentary approval for an extended Norwegian contribution to the renewed European effort in space cooperation. The Ministry's plans were, however, dramatically dashed at the European Space Conference session in November 1970 where the negotiations broke down the first day, due to profound disagreement between the European states.

Slowly, however, the European process gradually got back on track with the 'package deal' (1971) and the events leading to the formation of ESA.[92] In view of the new prospects for European space cooperation, the question was again raised in 1972 whether Norway should join this future organisation and, once more, the initiative derived from the Ministry of Foreign Affairs. The new round of discussions about Norwegian ESRO membership strongly coincided with the political debate on whether or not Norway should join the EEC and some of the key players in Norwegian science policy were tangled up in political engagements.[93]

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[90] The University of Tromsø, formally established in 1968, started its teaching on a regular basis in 1972. The programme for the new university comprised cosmic geophysics as one of its strongholds, and, as part of these plans, the university even absorbed the Auroral Observatory, which in 1972 was made part of the university.

[91] Memorandum 'Europeisk romsamarbeid og Norges deltagelse i det europeiske telesatellittprosjekt', Ministry of Foreign Affairs 23.2.1971 (NTNF arch.).

[92] J.Krige, A. Russo et al: *A History of the European Space Agency 1958-1987,* pp 289-293.

[93] Finn Lied was Minister of Industry in a Social Democratic government engaged in an embittered political campaign for support for Norwegian EEC membership. The issue was to be decided through a referendum at the end of September 1972.

As the European process continued, the eagerness demonstrated by the Ministry of Foreign Affairs was to be matched by increasing pressure from the European countries participating in space cooperation; Norway should join the cooperative effort and take on its share of the costs. In the opinion of important circles within ESRO it was time for Norway to end its role as a 'free rider' in European space cooperation. However, NTNF felt no need to hasten a decision to join. In fact, NTNF had shown little inclination to join the Ministry of Foreign Affairs in its renewed enthusiasm for European space cooperation. In September 1970, NTNF and NTNF's Committee for Space Activity advised that Norway should await clarification of the new European space cooperation before any decision was made on Norwegian membership.[94]

Why was it that the pro-European enthusiasm expressed by the NTNF space lobbyists in 1968 and 1969 had given way to a lukewarm wait-and-see attitude in 1970-1972? The answer is complex. The explanation is partly due to developments within Europe and the bleak prospects for a coherent European programme. Another set of considerations which influenced deliberations was the importance of space cooperation in Europe compared with the developments in the Atlantic arena. These developments in late 1969 and in 1970 were perceived in Norway, as in other European countries, as capable of turning international space cooperation upside down. Specifically, the developments were related to NASA's offer to the European governments, with the support of the United States government, to participate in NASA's post-Apollo programme, which meant planning for cheaper and safer ways of getting payloads into space.

With NASA's offer of open access to space technology cooperation, the question of joining European space cooperation took a new turn in Norway. What would be the benefit of joining Europe under these circumstances? Even when negotiations between Europe and the United States on the actual scope of the post-Apollo programme proved complicated, the Atlantic option still held its attraction for Norwegian space activity administrators. The United States had the unquestionable upper hand in space communication. When in 1968, maritime satellite communication had become the focus of Norway's programme for the industrialisation of space technology, attention was first turned towards the United States.[95]

In the dramatic referendum of 25 September 1972, the Norwegian electorate rejected EEC membership by a narrow majority. The Social-Democratic government stepped down, and a Euro-negative centre coalition took over. This, however, did not stop the Ministry of Foreign Affairs from renewing initiatives for a re-examination of the Norwegian attitude towards ESRO/ESA. The Ministry appointed a committee in the spring of 1973 to examine the potential importance of ESRO/ESA membership for Norway and to advise on 'possible forms of adhesion' to the new organisation. NTNF received the Foreign Affairs' initiative with some reserve.[96]

The Ministry of Foreign Affairs had followed the process leading to the adoption, at the ESC in December 1972, of the resolution determining the creation of ESA as one single European space organisation and was worried that Norway would not join. Norway had been allowed to participate as an observer at ESRO. The signal now was that observers would no longer be admitted. This was confirmed

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[94] Letter from NTNF to Ministry of Industry 23.9.1970; statement from the NTNF Committee for Space Activity 1970 n.d. (NTNF arch.).

[95] By 1972, NTNF was negotiating with NASA for the use of its projected ATS-F satellite to be launched by 1974 for testing the Norwegian ship terminal phased array antenna.

[96] The Executive Committee – now chaired by Finn Lied – suspected that 'NTNF might later be asked for economic support. The executive committee ought not to commit itself beforehand, and there should be no representation from the executive committee or from the NTNF's administration.' Minutes from the NTNF executive committee meeting 2.3.1973.KV's Bjarne Hurlen was picked to represent NTNF on the committee; the chairman of the NTNF's Committee for Space Activity, Bjørn Rørholt, also became a member. Among its other members the committee counted Anders Omholt, who had resigned his professorship and started working on research issues at the Norwegian Federation of Industries, Bjørn Landmark representing NDRE, Peder Th. Hiis representing Norwegian electronics producers, and representatives of NTA and the relevant government ministries. The Chairman was Ambassador Haakon Nord, representing the Ministry of Foreign Affairs on the NTNF's Committee for Space Activity.

by ESRO's Director of Administration, the upcoming Director General of ESA, Roy Gibson, at a meeting in Oslo in February 1973. Associate membership was also dismissed as a possibility.[97]

Later in 1973, the ESRO Member States again exerted strong pressure on the Norwegian government to join the programmes. The European powers taking part in the 'package deals' concerning European space cooperation were actively seeking partners to share the costs. The main reason for the Ministry of Foreign Affairs' interest in ESRO in 1973 undoubtedly relates to this fact. Norway was engaged in negotiating a trade agreement with the EEC and was keenly interested in showing willingness to contribute to common European efforts. The 'no' to the EEC in 1972 had not, in fact, made Norway less interested in the political implications of space development in Europe, rather the opposite.

The NTNF 'Nord' committee submitted a report with a split conclusion. The majority recommended full Norwegian ESA membership. The minority – the two representatives of the Ministries of Industry and of Church and Education – did not support the recommendation.[98] The text of the report stressed the necessity for Norway to follow up on the initiatives taken on the European space scene so that the nation would not be left behind in relation to technology development and scientific projects. The statements reflect a reversal of the lukewarm attitude shown by NTNF's Committee for Space Activity in the years from 1970 to 1972.

There were two important reasons for the turnabout. Firstly, after the second 'package deal' concluded in July 1973, there was no longer any doubt that the European organisation would become a reality, with practically all western European countries as members. Secondly, the Atlantic option, in conjunction with the post-Apollo programme offer from NASA, was no longer credible, to some degree a result of the Nixon administration's choice to restrict the scope of the cooperative programme. It was to Norway's advantage that it had been able to cooperate freely in both the European and the Atlantic circles. The signs now were that the two circles were merging into one, from which Norway risked exclusion.

## ESA membership rejected

With extra funding as a condition for ESA membership, the recommendation from the Nord committee was doomed to fail when it was presented in December 1973. The Ministry of Finance had made it clear that expenditures for ESA membership would mean that funding would have to be reallocated from other Norwegian scientific research. NTNF pointed out that this was not tenable: 'space activity' could no longer be regarded as research activity.[99] The proposed ESA membership was not received any better from the science community. Both NAVF and the Central Committee of Norwegian Research advised against membership, and they were seconded by the Ministry of Church and Education and the Ministry of Finance. That settled the matter. In the final days of March 1974, the government concluded that it would not seek full Norwegian membership in ESA for the time being, but that some sort of association would not be excluded in the future.[100]

NAVF had submitted a very thorough and very critical examination of the ESA membership proposal from a scientific point of view, concluding that the bulk of ESA's scientific programme would not be in the field of cosmic geophysics, in which Norway had a long tradition and high-quality on-going activity, but in the fields of astronomy and astrophysics, fields in which – solar physics excluded – Norwegian

[97] Minutes from meeting at Ministry of Foreign Affairs 26.2.1973. (NTNF arch.).
[98] They were pointing to what the Ministry of Finance had stated when the committee was nominated, namely that 'the committee has to be made aware that its recommendations must be held within the limits of the [government] long term budget and that Norwegian expenditure on extended European space cooperation will be at the expense of other Norwegian research activity'. Letter from Ministry of Finance 19.6.1973, quoted in Nord committee report The setting up of the Nord committee had been a Ministry of Foreign Affairs initiative, but the views advocated by the committee's majority very much reflected the concerns of those responsible within the NTNF's Committee for Space Activity and the NTNF Space Activity Division. It seems that the members forming the Nord committee's majority came to the conclusion that the train was leaving the station, and that this would be the last chance to catch it.
[99] Letter from NTNF to Ministry of Industry 28.1.1974 (NTNF arch.).
[100] Letter from NAVF to Ministry of Church and Education 17.1.1974; letter from the Central Committee for Norwegian Research to the Ministry of Foreign Affairs 1.2.1974; letter from the Ministyv of Church and Education to the Ministry of Foreign Affairs 18.1.1974; letter from the Ministry of Finance to the Ministry of Foreign Affairs 18.1.1974.

scientists were not particularly strong, and where there were few ongoing national research programmes.[101] The NAVF statement reflects how Norwegian space-related science had, through its expansion from the 1960s onwards, been both diversified in scientific programmes and differentiated institutionally. The build-up of cosmic geophysics at the University of Tromsø had been supported by the NTNF's space lobby. Now, the institutions in Tromsø had become rivals. They had acquired a weight of their own and were not necessarily subject to the control of NTNF's Committee for Space Activity. Increasingly, NTNF's programme for space activity was becoming a programme for applications and industrialisation. Even when NTNF continued its support of scientific space research, there was a feeling of increased distance between applied and pure space research.

The 1974 decision to decline ESA membership was a rerun of the 1962 decision concerning ESRO. European space cooperation was not seen as important enough for science, nor for industry, for the necessary funding to be assured. Compared with 1962, however, some things had changed. Space science had proliferated without ESRO membership and EISCAT was an important example of a non-ESRO/ESA international cooperative programme. Additionally, space applications now carried much greater weight, primarily in one sector – telecommunication – which, in all matters, could be regarded as more of an extended international undertaking than a merely European one. The decision can also be understood from a situation of extremely tight budgetary constraints on Norwegian state agencies. According to some, including Roy Gibson observing the developments in Norway at the time, the situation with Norwegian ESA membership could have been different if budgetary conditions had been better.[102]

Ultimately, the foreign policy climate surrounding the space cooperation issue rapidly changed. The foreign policy issue – Norway's attitude to European integration – which had given impetus to the renewed attempts to participate in European space cooperation, had vanished. The support from the Ministry of Foreign Affairs was withdrawn.

Despite Norway's rejection of ESA membership, NTNF took the initiative for obtaining governmental support for Norwegian participation in Marots. After intensive lobbying at the Ministries of Industry, Trade, Transport and Communication, and Foreign Affairs, NTNF succeeded in ensuring government assent. In June 1974, the government decided for Norwegian participation in the programme and was welcomed as a Marots-member at the ESRO Council meeting on 26 July 1974. Norway remained a participant in Marots until its termination in 1982. ESRO/ESA was constantly seeking partners to share in the funding of their programmes. However, it was the first time that ESRO had admitted a non-Member State to one of its programmes.

## Remote sensing at the centre of Norway's space effort

Unlike maritime satellite communication, the other field of space technology applications that emerged during the 1970s as important for NTNF's space effort, ground remote sensing, was not to be crowned with the same commercial success. However, it was in this field that a new space strategy was defined, which would eventually lead to Norway's accession to ESA, first as an associate member and eventually as a full member.

At the beginning of the 1970s, NASA launched its Landsat programme, intended as a series of Earth Resources Technology Satellites (ERTS). In order to acquire a broad basis for the initial definition and testing stage, NASA issued invitations to its international cooperative partners for participation in the experiments. In Norway, NTNF's Space Activity Division served as an intermediary for NASA's invitation, and Norway eventually became one of 38 countries participating in the first ERTS experiments on Landsat 1 and 2.[103]

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[101] Given the limited budgetary resources, Norwegian science could not afford both ESA membership and EISCAT, NAVF concluded, and EISCAT was preferred.

[102] Memo from R. Gibson to Director General, ESRO, 1.3.1973 (ESA arch. file 60190).

[103] At NTNF's suggestion, five Norwegian groups submitted proposals for participation in the first experimental programme, namely the ERTS-1 launched in July 1972 (later renamed Landsat I). The experiments ranged from studies of sea ice in the Svalbard area and evaluation of snow storage in catchment areas of hydro-power stations, to methods of photo-geological investigations.

This was not Norway's first experience in using satellite technology for remote sensing and in the gathering of information on natural phenomena from in situ measurements. Since the beginning of the 1960s, buoys had attracted interest in Norway as a means of measuring physical parameters in the ocean environment.[104] With the advent of satellite remote sensing, it was felt in informed circles that the world was on the threshold of a revolutionary development.

With the change in the political climate after the EEC referendum, two general lines of political action became central to the Social Democratic government's policy of the 1970s and would also influence the field of remote sensing by satellite. One was an increased emphasis on environmental issues, especially the management of natural resources. The other was a policy for regional development and support of the primary sectors of the economy, agriculture and fishery.

What first provoked NTNF into taking initiatives for increased Norwegian activity in the field of satellite remote sensing were worries concerning the future of the Tromsø Telemetry Station. The contract with ESRO for the use of the Tromsø station was due to lapse on 1 July 1974. After that, the station would be without sufficient employment to cover the running costs and the salaries of the staff.[105] With Norwegian ESA membership, there could have been hope for a place for Tromsø in a reduced ESA telemetry network. When the decision was taken not to join ESA, the problems became acute. In a first, rather desperate, effort NTNF's Committee for Space Activity considered selling the Tromsø station to ESA, but this idea was soon given up.

The alternative that emerged was to further develop the station to make it capable of downloading Earth resource data from the NASA Landsat satellites, an idea that had already been discussed in early 1973. This called for an upgrading of the Tromsø station. Given its budgetary constraints, NTNF had no alternative but to try to mobilise support from potential users, at both a national and a Nordic level. A NTNF Subcommittee for Remote Sensing was established in 1974, with representatives from the institutions participating in the ERTS experiments.

The Nordic solution proved to be ill-suited for this purpose because of the competition between Sweden and Norway regarding installations serving ESA, especially concerning the need for a telemetry network in the high north[106]. It was then clear that Norway had to finance a Landsat ground station on its own. In 1975 and 1976, there was very active campaigning for obtaining such funding.

In a direct intervention at the highest government level, Finn Lied, now acting as Chairman of the NTNF's Executive Committee, succeeded in obtaining government endorsement of the plans in the summer of 1976. In the budget proposal for 1977, the government included NOK 7.5 million for the establishment of a Landsat ground station in Tromsø. Instrumental for this outcome was the presentation of a vision of satellite-based surveillance of Norway's territorial waters, and of the oil and fishing activity off the Norwegian coast.

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[104] Odd Dahl, with the staff at the Chr. Michelsen Institute, had been actively developing instrumented buoys in cooperation with the internationally recognised group of Norwegian oceanographers centred in Bergen, with support from the NATO Science Committee. In 1969 it was decided to build a Norwegian experimental buoy to evaluate buoy data transmission via satellites by means of the NASA ATS-3 spacecraft which was launched in 1967. Through their participation in the European cooperative research programme COST. Norwegian oceanographers and engineers were central in the process of standarising buoys for oceanographic measurements.

[105] The Tromsø station had been downloading data from Canadian, U.S. and European satellites in polar orbit. What really had assured the economy of the station, however, was the work done for ESRO's scientific satellites – ESRO IA and 1B, ESRO-2B, HEOS-1 and HEOS-2, TD-1A and ESRO-4. With the latter, however, ESRO's programme for polar-orbit satellites was terminated.

[106] With both the Tromsø and the Kongsfjord station due to be closed in 1974, ESA would be without a telemetry station at a northern latitude. Even although the satellite programme was to be reduced, ESA would still need a northern telemetry station for future use. In internal ESRO documents, a Scandinavian telemetry station was included in a future reduced telemetry network. However, with Norway remaining outside ESA, it could be difficult getting Tromsø as the ESA station.

## Satellite surveillance for Norway's new ocean territory

The Norwegian Parliament decided on the proclamation of a 200-mile economic zone at sea to be effective from 1977. This would mean a huge increase of Norwegian territory. More than one million square kilometres were covered by the new zone. The enormous surface of the seas now under Norwegian jurisdiction contained natural resources of the greatest importance to Norway's economy: fish and, to an ever increasing degree in the late 1970s, oil. For Norwegian sovereignty over this zone to be effective, regular surveillance would be necessary. The best way to do this, according to Lied and other key players within the space activity segment of the Norwegian science policy establishment, was to use the means becoming available with surveillance satellites, especially the technology of Synthetic Aperture Radar (SAR).

Belief in satellite surveillance as the answer to Norway's need for the control and surveillance of her sea territory led to a breakthrough in government support for Norwegian space activity. For the first time, space activity was linked to important overall government policy considerations. With government support in the pocket, NTNF started negotiations with NASA for the instrumentation and use of the Landsat station in Tromsø. However, what the Norwegians believed would be bilateral negotiations between the United States and Norway, were traversed by developments in Europe and the Swedish decision to establish a ground station for Landsat at Esrange.

What made the Swedish ground station plans threatening to the Norwegians was their link with the European space cooperation programme under ESA. ESA wanted to coordinate European activity in Earth remote sensing vis-à-vis NASA, and intended to support the establishment of two ground stations for Landsat in Europe.[107] A discussion followed in which the Norwegians tried to prove their case for a station in Norway. ESA's management suggested that Kiruna and Tromsø should enter into an agreement by which they would join forces and share responsibilities. Tromsø could take responsibility for the downloading of data, while Kiruna could perform data processing. However, this alternative was turned down by the Swedes, as they pointed to the Swedish prerogatives as a member of ESA. Subsequent negotiations between Norway and Sweden marked a low point for Norwegian-Swedish relations in space matters. In October 1976, ESA decided to enter negotiations with Sweden for a Landsat station at Kiruna. Norwegian efforts had been to no avail. The Swedes refused to cooperate; the ESA Landsat station in northern Europe would be built in Kiruna and the economy of a projected station in Tromsø would be undermined.[108]

The story of the Landsat station in Scandinavia was the fulfilment of the Norwegian nightmare as it had been foreseen in the report by the NTNF Nord committee in 1973, implying that the Atlantic and European circles of space cooperation would merge into one. More than bilateral United States-Norwegian negotiations were needed for the establishment of a Landsat station in Norway when ESA decided to enter negotiations with NASA for the use of Landsat on behalf of its Member States.

In Norway, the options seemed to be to join ESA or shut down the station in Tromsø. But then issues of national security emerged as a reason for sustaining and expanding activities at the TSS. The alternative that NTNF and the Norwegian government decided on was to make the most of cooperation in the Atlantic circle without European participation. At the prompting of NTNF's Committee for Space Activity – with Lied and NDRE obviously pushing behind the scenes – it was decided to alter the plans for the Tromsø station. Instead of equipping it for Landsat, it would be directed towards oceanic surveillance and be equipped for reception of data from Seasat A. This revised programme was approved by the government and by the Storting in the spring of 1977.[109]

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[107] One would be the Italian station, the other was to be located in northern Scandinavia.

[108] Meeting of ESA's Remote Sensing Programme Advisory Board (RESPAG) 22.10.1976, referred to in note from NTNF 25.10.76 (NTNF arch.).Letter from Swedish Minister of Industry Olaf Johansson to Norwegian Minister of Industry Bjartmar Gjerde 10. 12.1976 (NTNF arch.).

[109] The changed programme for the Tromsø station was presented such that the station would be serving satellites for 'surveillance of the fishery zones, the continental shelf and the Arctic region', in which fields 'the most interesting perspectives for Norway are found for the use of satellite data'. Letter from NTNF to Ministry of Industry 19.1.1977, quoted in St.prp. nr. 167 (1976-77). It was a programme for the use and development of the most advanced satellite surveillance technology – SAR.

By the end of 1977, a joint project was defined with NDRE, the NTNF Space Activity Division, and the Institute for Radio and Signals Theory at NTH as participants. It aimed at developing the necessary computing hardware and software for the processing of SAR data to be installed at the Tromsø station. With support from the Ministry of Defence, as well as the Ministry of Industry, the project materialised in the development of a Computer for Experimental SAR – CESAR – in which Norsk Data later joined as the industrial partner.

The inherent risk in the plans became obvious when Seasat A, launched in 1978, ceased functioning after just 104 days in orbit. The Tromsø station had been able to telemeter signals from the satellite for two minutes before it failed in October 1978.[110] In spite of this setback, the plans for the Tromsø station were continued. By 1982, the Tromsø Telemetry Station was again in full use. The use which was made of the station was other than initially planned since it became the national ground station for the search and rescue service provided by the international SARSAT/COSPAS system.

## The return to Europe

1977 marked a new turning point in Norwegian space activity and the way it was defined. With the vision of satellite technology as a tool for the surveillance of the newly acquired Norwegian oceanic territory, combined with the plans for the upgrading of the Tromsø Telemetry Station and for the development of a computer for fast processing of satellite radar data, a recipe was found which linked space developments to important Norwegian interests as a maritime power.

There was also a shift in the people and institutions defining space policy. The most important one was the way in which the Ministry of Industry now took an active interest in space technology development and became an important promoter of space programmes.[111] Between 1973 and 1977, there was a shift in the Ministry's perception of its aims as well as its mode of operations, much as a result of the influx of oil revenues from the North Sea. With oil, Norway found itself in a totally changed economic situation.

The counter-cyclical policy started in 1975 by the Norwegian government, aiming at sheltering Norwegian industry from the effects of the downswing in the world economy, was not successful. Increasingly, technological innovation became the focus of industrial policy from the second half of the 1970s.[112] Starting in 1978, when the policy of using oil wealth for the support of ailing industry was finally abandoned, this became the focus of a reorientation of policies.[113] New schemes were developed for making use of oil resources with the intention of supporting industrial innovation. The idea was to enter into agreements with countries buying Norwegian oil in order to obtain cooperation in technology development and technology transfer. Under such agreements, it was hoped that Norway would be able to take part in the development of frontline technology, and Norwegian industry and research institutes would be accepted as partners of leading European firms and research centres. Towards the end of the 1970s, this became one of the pillars of a national technology policy. Norwegian oil should be exchanged for the opportunity of participating in advanced technology development programmes.

In negotiations with France and the Federal Republic of Germany that were to follow, space technology played a significant role. Bjørn Landmark, who had taken over as Head of the NTNF Space Activity

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[110] The blow to the plans for the Tromsø station was even more serious as the Seasat A was a one-of-a-kind satellite with no backup, and with no funding available for the launching of a new satellite.

[111] Up to the mid-1970s, there had been little interest expressed by the Ministry of Industry for space technology. As mentioned above, the Ministry's representative on the Nord Committee discussing a possible ESA membership in 1973 had been very sceptical, and had pointed to other unresolved problems for Norwegian industry of much more importance than space programmes.

[112] It was recognised that the structural changes which had affected American and European industry could be met only through an active policy for supporting changes in the existing structures, especially for encouraging the development of new products and for employing new production and processing technologies.

[113] As a senior civil servant at the Ministry of Industry, and with close links to the Social Democrats in government (he had served for a total of six years as State Secretary in the Ministry of Finance and the Ministry of Industry in the 1950s) Gøthe had acquired great authority. In the second half of the 1970s Gøthe was decisively influencing Norwegian industrial policy.

Division in 1977, was brought into the negotiations. Landmark's extensive network in European space circles was an important asset for the new industrial and research policy, and space technology was targeted as one of the frontline technologies in which it would be important for Norway to take part.

Bilateral agreements with France and the Federal Republic of Germany concerning space marked a new opening for Norwegian participation in European space cooperation. In 1979, they were followed by a renewed attempt at gaining support for Norwegian ESA membership.[114] In the history of Norway's relations with the European space cooperative effort, this was the decisive turning point, leading first to Norwegian association with ESA and later to full membership. The decision for a renewed initiative for membership was taken by a small group of people, including Bjørn Landmark, Finn Lied, Robert Major and others who had been active in shaping Norwegian space policy for almost twenty years.

Contacts with ESA concerning possible Norwegian membership started early in 1980. The Norwegian overtures were given a favourable reception by ESA. However, in a meeting in Oslo in March 1980 with a delegation from ESA, headed by its Director General Roy Gibson, it was agreed that full Norwegian membership was most likely premature. Instead, Gibson suggested an associate membership, which the ESA Convention permitted.[115] With the decision taken to apply for an associate membership, the process leading to the signing of the agreement went smoothly. The only government agency that openly voiced reservations was NTA. After final negotiations of the terms of Norway's associate membership, the association agreement was signed at ESA's headquarters in Paris on 2 April 1981. It was approved by the Storting a few weeks later. The agreement came into force starting 1 November 1981. Thus, Norway had decisively joined the 'European circle' for space cooperation, in expectation of becoming a full ESA member.

At the same time, the European Remote Sensing (ERS) programme was moving in a direction of interest for Norway. In a letter sent earlier in 1979 to the Ministry of Industry proposing ESA membership, NTNF had recommended that Norway take part in the ERS programme, together with Marots in which Norway was already a participant. Norway's wish to participate – which was confirmed by the NTNF's Executive Committee in November 1979 – was received most favourably by Roy Gibson. ESA's Council gave its approval at the end of 1980.[116]

With computer processing of SAR data as the focus of the Norwegian industrial programme in the space field, it was of particular interest to take part in an ESA programme in which SAR would be one of the central instruments. For example, the ERS-1 satellite was planned for launch in 1986. Norwegian firms and research institutes would be excluded from such promising projects[117] if Norway did not opt for ESA membership. The development of remote sensing technology and the full use of the TSS were further arguments for full membership.[118] That Norway decided to opt for associate membership, and not full membership, was linked to the immediate benefit expected from the expenditures that a membership would entail. Norwegian industry would hardly be able to obtain contracts equivalent to the normal industrial return from ESA's programmes. As an associate member, Norway was obliged to take part in the financing of the basic common programme, but otherwise had the option to choose the programmes in which it would like to take part.

## Telecommunication satellites for Norwegian purposes, and the failure of Tele-X

After an initial period when technology development cooperation in the Atlantic circle had stood out as the most promising for sea surveillance satellite technology, Earth remote sensing was found to be best addressed for Norwegian purposes in the European cooperative framework constituted by ESA. In the

[114] Landmark had taken up the question of Norwegian ESA membership as soon as he had assumed his new functions at NTNF in 1977.
[115] The transitional period would be from three to five years, following which Norway would decide whether or not to join ESA as a full member.
[116] Letter from R. Gibson, ESA, to B. Landmark, NTNF, 14.12.1979.
[117] ESA had reportedly already rejected a possible contract with ELAB for the programme, on the grounds that Norway was not a participant.
[118] Minutes from meeting of the NTNF's Subcommittee for Remote Sensing 26.10.1976 (NSC arch.).

field of satellite telecommunication, on the other hand, NTA relied partly on an Atlantic and partly on a European framework for cooperation.[119]

Apart from Marots, NTA voiced scepticism towards participation in European space telecommunication programmes, but it was interested in the use of satellites for the telecommunication challenges of the new oil industry. A proposal presented to NTA was to lease transponder capacity on an Intelsat satellite for relaying telephone connection to the North Sea. This was, in itself, an innovation.[120] In cooperation with those responsible for satellites at NTA and the research staff at Norwegian Telecom Research (NTR), a system for satellite communication with the North Sea was realised in a remarkably short time. In less than one year the Norsat A system was specified, the equipment purchased, and the service brought into operation in 1976. Norsat A was a breakthrough for satellites in Norwegian telecommunication. However, it depended largely on support from oil companies. The ground station at Eik, Rogaland, which was the most costly investment for the Norsat system, had to be financed through loans from oil companies.

Concurrent with the emerging need for communication with the North Sea, a unique challenge for Norway was the increased need for communication with Svalbard. After an extensive experimental programme, a permanent ground station at Isfjord, linking Svalbard to the Norsat system, was made operational in December 1979.[121] Due to its geographical position, telecommunication satellites provided efficient solutions to Norway's particular telecommunication problems. In its satellite operations, NTA made practical use of the satellite systems already available.

With the advent of direct broadcasting satellites, a plan was introduced for a Scandinavian development programme in space communication technology which was radically different from the projects that NTA had supported. The story of the most ambitious, and most expensive, project for Nordic cooperation in the development of satellite technology – the Tele-X telecommunication satellite – is a highly dramatic chapter in the history of Scandinavian space development.[122] Its mere size places the Tele-X in a special category among Scandinavian space projects. With a price tag of NOK 1.5 billion, Tele-X was the single most expensive Scandinavian space project ever undertaken.

At a meeting of the Swedish and Norwegian Ministers of Industry in August 1981, Norway was approached by Sweden which offered a stake in the project.[123] Support for Norwegian Tele-X participation was expressed by a number of Norwegian industrial firms wanting to take part in the project. Norway having just joined ESA as an associate member, the Ministry of Industry used the study contracts as part of its strategy for an expansion of Norwegian industry in space technology.

In April 1983, agreements between Norway and Sweden concerning the Tele-X projects were signed by the respective Ministers of Industry.[124] On 2 April 1989, three years after schedule, Tele-X was successfully launched by an Ariane 2 launcher from the ESA launch site in Kourou, French Guiana.

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[119] Intelsat assured Norway and other countries of reliable telephone and television connection globally. Through Marots NTA had become closely involved in the definition of a global maritime satellite communication system, leading up to the establishment of Inmarsat.

[120] Intelsat's statutes contained clauses that made such arrangements difficult. However, through its successful alliance with the other Nordic telecommunication administrations, NTA had been represented in Intelsat's executive bodies and was able to obtain the organisational support necessary for an approval.

[121] In 1978, ESA's Orbital Test Satellite (OTS) had been launched for broadcasting experiments. Experiments with the reception of signals from OTS on Svalbard were successfully started in 1979. From 1984 the Norwegian Broadcasting Corporation started experimental broadcasting to Svalbard on the Eutelsat 1, with a regular service being established in 1986.

[122] The story of Tele-X is treated comprehensively by Nina Wormbs: *Vem älskade Tele-X? – Konflikter om satelliter i Norden 1974-1989*, Gidlunds förlag, 2003.

[123] 'Norsk deltagelse i Tele-X', report to the Ministry of Industry, April 1982 (NSC arch.). The report was submitted by a committee chaired by Professor Gunnar Stette, NTH. The NTNF Space Activity Division had served as secretariat to the committee.

[124] Initially, Norway had been invited to take a 25 percent stake in the project. The Norwegian government insisted on having this reduced to 15 percent, equalling some NOK 245 million, which would be more reasonable in proportion to the limited Norwegian industrial participation. Finland was also negotiating participation and was offered a 10 percent stake, but limited its participation to a mostly symbolic 3 percent.

Technically, and as an industrial project, it was a success. For many years to come Tele-X was functioning perfectly in orbit. However, from a political and operational point of view, Tele-X had become a disaster. It had been heralded as a model of Nordic cooperation. When it was finally launched, it aroused the ironic comment that this was done only because it was less expensive than breaking it up. Commentators pointed out that the Nordic countries had managed to do what no other country had previously done, to produce and launch a satellite without any specific use.[125] Only a few days before Tele-X was launched, the Norwegian government decided to pull out of the project.[126]

The fate of Tele-X gave rise to disappointment and bitter feelings. This was mainly due to the fact that Tele-X was the most ambitious attempt ever at developing satellite technology in a Nordic cooperative setting. As stated earlier, Scandinavian satellites had been discussed starting in the mid-1960s. The most remarkable failure of the Tele-X project was the way it demonstrated the impossibility of obtaining Scandinavian cooperation in the production and transmission of television programmes via satellites, which was the use for which it initially was intended. The satellite capacity was finally leased for other purposes.

## Norway towards full ESA membership

The process, started in 1976-1977, which defined Earth remote sensing as the central space application field for Norway, especially for the surveillance of its large sea territory, was successfully coupled with the changed industrial policy from the late 1970s with emphasis on technological innovation. This coupling was the basis of Norway's association with ESA in 1981.

With the Ministry of Industry maintaining the initiative, the following years were used for widening the dual vision of satellite surveillance and industrial growth through space technology development. A committee was appointed by the government in 1982 to advise on a national programme for satellite remote sensing. The commission's recommendations were that Norway should join ESA's ERS programme and should carry out the upgrading of the Tromsø Telemetry Station as a ground station for the ERS satellites.[127]

Adherence to ESA's remote sensing programmes would be central to the Norwegian programme. The committee advised that Norway should join ESA as a full member in 1986, when the transitional phase of associate membership was due to lapse. The recommendations of the commission were taken up by the Ministry of Industry and brought to fulfilment. In 1985, the Storting approved the government's proposal for Norwegian participation in ESA's ERS-1 programme, with the goal of launching the first ERS-1 satellite by 1989.

The Ministry of Industry added to its proposal that 'the Ministry, in cooperation with industry, the interested ministries, research councils and organisations, will start defining a national space policy'.[128] In April 1985, the government decided to enter into negotiations with ESA for full Norwegian membership and, in May, the Ministry of Foreign Affairs appointed a delegation to represent Norway in the negotiations. When the committee on space policy was appointed two months later, it was instructed by the government to base its report on the assumption that Norway would become a member of ESA with full rights and obligations on 1 January 1987.[129]

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[125] Comments in Dagbladet, 30.3.1989, and Arbeiderbladet, 3.4.1989.
[126] Letter from NTA to Ministry of Transport and Communication 1.6.1982 (NSC arch.).
[127] The chairman of the committee was Finn Lied. The committee's report, submitted in June 1983, was an authoritative summing up of the programme for Norwegian participation in remote sensing that Finn Lied especially had advocated from 1976 onwards. NOU 1983:24: 'Satellittfjernmåling', report from a commission nominated by the government 15.10. 1982, submitted to the Ministry of the Environment 10.6.1983.
[128] St.prp. nr. 48 (1984-85) 'Om fortsatt norsk deltakelse i Den europeiske romorganisasjonen ESA's satellittbaserte fjernmålingsprogramme ERS-1'; lnnst. S. nr. 148 (1984-85).
[129] Note to the cabinet from the Foreign Minister 1.9.1986 (NSC arch.). Royal decree of 26.7.1985, quoted in NOU 1986:1 'Norsk romvirksomhet'.

Membership in ESA was steered through the government as an industrial policy issue. Other Norwegian interests were also cited in favour of ESA membership. Foreign policy interests would be served by Norway's accession to ESA. Also, scientific research interests now unanimously supported ESA membership. NAVF had submitted a favourable statement, and so had the Research Policy Advisory Council, the advisory body that had succeeded the Central Committee for Norwegian Research. By carefully enlisting the support of science, the Ministry of Industry avoided a rerun of the 1962 or 1974 situation where ESRO/ESA membership was rejected as a result of opposition from NAVF and the Central Committee. ESA membership was, in 1985, seen chiefly as a matter of industrial policy, but at the same time sufficiently attractive to science to minimize any opposition from this field.

After negotiations with ESA, which defined the conditions for Norwegian entry into the organisation, came to a conclusion, the government, on 6 December 1985, gave its final approval and on 12 December 1985, the formal membership agreement between Norway and ESA was signed in Paris at ESA's headquarters by the newly appointed Minister of Industry Petter Thomassen.[130]

During all the years before the official membership, the question of joining ESRO and later ESA had been continually discussed. Why did it take all this time before the decision to join was made? It took a long time, and much energy, to persuade Norwegian politicians and bureaucrats that it was necessary for Norway to take an active part in global space development. It was necessary to present space activity as something useful for a small nation, and not as a field for the massive spending of money in projects related to defence or national prestige. Extensive campaigning to minimize the 'big science' and 'big power' images and to gain approval for an understanding of space activity as a means for solving practical problems were required, even for a small nation such as Norway. Satellite surveillance of Norway's sea territory was the formula that paved the way for Norwegian ESA membership. In this case, the proponents of space had been able to harmonise space policy with national priorities.

ESA membership concerned the way in which national space interests were defined. As primarily a user of space technology, the Atlantic framework of cooperation was perfectly adequate, as was shown, for instance, by NTA's membership in Intelsat. On the other hand, if Norway were to take part in the industrial development of space technology, the Atlantic circle was not appropriate or sufficient.

With the Ministry of Industry taking up space technology as part of an active policy for industrial innovation from 1977 onwards, the ambiguity that had characterised the space field was gradually vanishing. Association with, and later membership in, ESA would be essential for Norwegian industry to gain access to frontline technology. This was the formula that ensured the support of changing governments. The process leading up to ESA membership was started under a Social Democratic government. In 1985, the membership agreement was signed by a conservative Minister of Industry. When Norway's membership came into effect in 1987, the Social Democrats again were in power. However, the process went on steadily, undisturbed by political changes.

Other factors which catalysed Norway's entry to ESA were the lack of opposition from science and the interest expressed by Norwegian industry in the space field.[131] With Peder Th. Hiis as the Chairman of NTNF's Committee for Space Activity, as well as the spokesman for industry, Bjørn Landmark as Head of the NTNF Space Activity Division, Finn Lied as Chairman of NTNF's Executive Committee and Karl Holberg as a major player behind the scenes, the plan drawn up in 1977-1978 for Norway to join ESA was almost entirely the work of present and former NDRE associates.[132]

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[130] St.prp. nr. xx (1985-86) 'Om samtykke til inngåelse av avtale mellom Norge og Den europeiske romorganisasjon (ESA) om Norges tiltredelse til Den europeiske romorganisasjons Konvensjon med tilhørende betingelser og vilkår'.

[131] NAVF had these last years, after 1980, taken a strong position in favour of Norwegian ESA membership, the committee headed by Lied commented in 1986. It was no doubt of importance to this that the space science old-timer Anders Omholt had become NAVF's Managing Director from 1978.

[132] The circle could even be extended to the Ministry of Industry, where the NDRE researcher Andreas Mortensen in 1977 had been recruited as Odd Gøthe's associate and had played a central part in the Ministry's space policy.

With their different attitudes towards space and their differing ways of defining space as a field of interest to Norwegian society, the small group that had come into the field of space science and technology at NDRE in the late 1950s and early 1960s, had been the carriers of space as a vision for Norwegian society. With the decisions taken in 1981 and 1985 to join ESA, this vision was at last given official backing. It also was given unequivocal content. With ESA membership and the foundation of the Norwegian Space Centre in 1987, space was defined as a vehicle for Norwegian industrial development.

## Norwegian Space Activities Since Joining ESA

The Norwegian Space Centre (NSC) was established as a foundation by royal decree on 5 June 1987. Under the auspices of the Ministry of Industry[133] it was given the task of coordinating national space-related efforts, especially within the European arena. The Andøya Rocket Range was merged with the main office in Oslo, and the new organisational arrangements for national space efforts implied that NSC took over NTNF's responsibility for the space sector.[134] The reason for establishing NSC as an independent foundation and not as a state agency was the wish of the Norwegian parliament to create an efficient and non-bureaucratic institution for the coordination of activities, not as a new science council or as a part of the existing science policy establishment. NSC was given a wide responsibility for the national space effort, with activities deriving from ESA membership as a focus. The year 1987 marked the end of the search to establish clear-cut goals, and an official political and concrete administrative framework for space-related activities in Norway. The most significant token was yearly revised long-term plans starting in 1989, as a cooperative effort between the different segments from government, business and research, and with NSC as the coordinating institution.[135]

The 16-year period, spanning from 1987 until roughly the end of 2003, was a period of growth for the space-related activities in Norway. There were expansions in the number of personnel, the infrastructure, the budget figures, and the scope of activities in both research and industry. But while the key institutions in space industry and commercial technology development have seen relatively good times, the space research segments have experienced problems.

### Understanding the Norwegian space sector since 1987

A point worth explaining is the form and function of NSC in connection with other elements of the Norwegian space sector. Depending on the perspective, Norwegian space activities may or may not be seen as a coherent entity; some parts might be viewed as being more or less autonomous, especially the satellite communication segment.[136] When looking at the Norwegian space sector throughout the 1990s, by and large shaped by strategic choices between politics, industry, technology and science, the main institution for the making of guidelines and network efforts was NSC. Other important strategic bodies have been the Research Council of Norway (RCN) and the *Norsk Industriforum for romvirksomhet* (NIFRO: Norwegian industrial forum for space activities). These institutions have been linked to a multitude of other institutions and organisations on both governmental and civilian levels, some of which will be more closely presented.[137]

The Research Council of Norway was established in 1993 as a merger between the five research councils in Norway that were created after WWII.[138] RCN has had the role as the superior authority in deciding on research strategies in space science on a national level. There was a formal division of labour between NSC and RCN concerning Norwegian ESA membership. NSC has been responsible for funding the participation in the science programme, which is mandatory, in addition to the national industrial and

[133] Now Ministry of Trade and Industry

[134] After a reorganisation of NTNF in 1982, the Lied committee commented that the space activity situation had deteriorated. The NTNF's Committee for Space Activity had been dissolved, and the space field placed under the responsibility of the NTNF's Committee for Electronics and Computer Science. These changes had made it difficult to formulate and carry out consistent space strategies. When space activity was taken out of NTNF, it was in line with a general trend of relieving NTNF of the administrative responsibility for institutes carrying out research. The 'NTNF system' which had been under attack from the mid-1970s because it was seen as an unfortunate mix-up of political and administrative functions, was gradually dissolved through the 1980s. It was also in line with a government policy of increasingly directing NTNF's activities, for instance, through a national programme for information technology, also launched in 1987. This was a policy for a full reorganisation of the national research and development effort, re-aligning it in accordance with a policy for industrial innovation.

[135] Norwegian Space Centre, *Long term plan for Norwegian space activities, 1989-1992*

[136] NSC itself has compared the Norwegian arrangements to the French space administration CNES, and sees it as being the most similar type of organisation of national space activities.

[137] For a look at the rather complex organisational chart, take a look at one of the NLTPRs (NSC long term plans), for example the 2003-2006 plan of action: 34.

[138] e.g. NTNF, NAVF, and NLVF.

applications programmes. RCN has had the responsibility for prioritising and funding the national science utilisation of the ESA membership. During the 1990s, the basic research programmes under the Research Council were decisive for Norway to benefit scientifically from investments in ESA projects such as SOHO, Integral and Planck, as well as other international projects such as the Nordic Optical Telescope (NOT) and EISCAT, and the different activities at the Andøya Rocket Range, particularly the MIDAS campaign.

NIFRO was established in 1986 by a group of industrial companies and research institutions in Norway, under the organisational umbrella of the *Næringslivets Hovedorganisasjon* (NHO: Confederation of Norwegian Business and Industry). Initially, NIFRO's goal was to coordinate industrial space-related development in Norway. Its main focus has been on industrial growth, network development and competence building.[139] The main tool for policy building has been to disperse information to significant players in policy-making circles via events and meetings – the most important being an annual 'space dinner' arranged for representatives from government and business. NIFRO also participates in space-related educational efforts.

During the 1990s there was a lack of agreement between the different institutions of influence and power on what were to be the main priorities in Norwegian space science. A discord on science policy between NSC and RCN is actually a key element during the late 1990s for understanding what took place in the Norwegian space research sector, and were to be the important challenges in the future. One recurring subject of discussion has been Norwegian ESA membership, what it costs and what benefits it yields. This discussion is again related to the general debate on Norway's relations to the EU and the rest of the world.

## Administrative alterations and policy development within NSC

The most explicit administrative change of NSC from 1987 until 2004, was the change from an independent foundation to a public administrative body (January 2004), under the responsibility of the Ministry of Trade and Industry. However, in practice, this change was probably of minor significance. It was actually more of a cosmetic change caused by new Norwegian legislation regulating foundations. Another change was the establishment of the *Norsk Romsenter Eiendom AS* (NSRE: Norwegian Space Centre Properties) in 1995 to own and maintain the buildings, and other infrastructure at TSS and the Svalbard Satellite Station. This was a part of developments in the 1990s and the first years of 2000 to split operative and commercial activities into wholly or partly owned subsidiary limited liability companies.[140]

NSC has had two managing directors since it was established, and both can be said to have shared the same perspective and main focus on industrial strengthening and technological development. They both share a background in business and high technology industry. Pål Sørensen was the Managing Director of NSC from 1988 to 1998.[141] Rolf Skår, at that time the leader of NSC's board, succeeded Sørensen. The composition of NSC's Board of Directors in its first years reflects the way the Ministry of Industry had supported space activity as an effort for industrial growth, and this trend has continued throughout the period of Norwegian ESA membership. Representatives of science and research institutions have always been in a minority on the board and, to some extent, in the NSC Council.[142]

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[139] Members of NIFRO are currently (2004: according to: www.nifro.no) Ame space AS, Andøya Rocket Range AS, Cap Gemini Ernst & Young Norge AS, Det Norske Veritas AS, Eidsvoll Electronics AS, Kongsberg Defence & Aerospace, Kongsberg Satellite Services AS, Kongsberg Seatex AS, Kongsberg Spacetec AS, Nammo AS, Nera SatCom AS, Presens AS, Prototech AS (see also Space Profile), SINTEF Group, TSAT AS, Telenor Satellite Broadcasting AS.

[140] NSC, annual report, 2001: 2

[141] Pål Sørensen was appointed the 1st July 1988. At the same date the space centre also established an advising council. NSC's first full working year was 1988. Before the centre had an official leadership, an interim managing committee comprised by delegates from the ministry of industry and NTNF was given the administrative responsibility. Norwegian space old-timer Bjørn Landmark acted as the provisional director during 1987-1988.

[142] The first Chairman of the Board was Trond Vahl, with a broad industrial background in computing and maritime technology. Vahls follower Rolf Skår, was one of the founders of and a long-time Managing Director of *Norsk Data*, and subsequently the last Managing Director of NTNF before it was incorporated in the new merger of the NFR, the Research Council of Norway in 1993. Pål Sørensen on his side had a combined background from research and industry. Kari Kveseth, from the Research Council

The preponderance of industrial considerations has been clearly visible in the way that NSC has presented itself and the Norwegian space sector in annual reviews and long-term plans.[143] Two, late 1990s, reflective thoughts on Norwegian space activities in general, presented in the annual reports of 1997 and 1998, sum up the perspectives of NSC in the previous decade. The first, presented by Pål Sørensen in his last editorial as Managing Director, describes the space sector in Norway as being predominantly 'down to Earth', both literally and metaphorically because of the focus on ground stations, remote sensing and other space activities which are Earth focussed or which deal with near-space, and heralding in a positive manner the pragmatic approach stemming from a traditional national need for turning every penny.[144] The second reflection was presented by Rolf Skår, in his first editorial as Managing Director in 1998, when he spoke of the main concern of Norwegian politicians and administrators as being the cost efficiency of space activities: 'Amongst the 14 countries that constitute ESA, Norway often must be described as a member out of the ordinary due to the way it has prioritised its investments in space activities differently.'[145] In addition, Norway was regarded as different in the way it related to matters of national requirements, and in the way that investments were decided according to their commercial potentials, and that this has counted for more than '[…] prestigious projects clearly visible in the media.'[146]

These two contemplations on Norwegian space activities set the tone for further investigations in these matters.[147] Norwegian space activities has always been 'down to Earth' and different, both in view of the practice and the policies employed. This has mainly been due to the lack of resources in a small country, but also from the political and diplomatic contexts.

## The contextual conditions of space policy-making in Norway since 1987

Norwegian space policy has in no way been planned or performed in a national vacuum for the last 40 years, and particularly not for the last 15 years. Three contextual conditions should be mentioned as important for the way that the making of Norwegian space policy was conducted during the 1990s. Firstly there are the relations to ESA, which were linked to the EU question in general, and the connection to other international communities and markets outside the EU. Secondly, there is the end of the Cold War, and the possibilities and problems presented by the new political climate also related to the development within, and in connection to, ESA. Thirdly, there is the use of space activities in general as a tool for the development of Norwegian society, and the necessity of serving governmental and societal user needs.

In the 1980s, and earlier, investments in space must generally be seen in the context of a continuous struggle for power in a Cold War setting. There was a never-ending determination for military, economic and technological mastery which released funds for ambitious space technology programmes dictated by

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of Norway, has been the chairman of the NSC Council since 1994. She represents a perspective on the Norwegian ESA membership and the payments into the scientific programmes that somewhat contrasts the NSC line.

[143] The web pages presenting NSC (www.spacecentre.no) state: 'The Norwegian Space Centre (NSC) has a down-to-Earth approach to space activities. Use-value is the catchword.'

[144] The Norwegian phrase is 'jordnær', implying a positive sense of pragmatism serving daily needs, but also a secondary, ironic and traditionally often more negative sense of being 'grounded'. Pål Sorensen's wording is as follows: 'Ikke bare er vår romvirksomhet jordnær, den foregår også for en stor del på bakken.', NSC, Annual Review 1997:3. Pål Sørensen was allegedly known to be regarding research as something of a 'dirty word', especially in the context of basic science and using large sums of money on something that had no means of utilisation in the foreseeable future. His mantra, frequently reflected in the editorials in the annual reports of NSC, was to underline the importance of space activities being a 'healthy' business with the need to make money and to keep the Norwegian space feet 'on the ground'.

[145] The Norwegian term used was: 'annerledesland' ('A different type of country'), a popular and widely used, although not presise, phrase in the newspapers and other types of media when trying to encompass the totality of what is 'Norwegian' in thought and action.

[146] NSC, Annual Review, 1998: 3, Introduction: 'Blant ESAs 14 medlemsland er Norge av og til et annerledes land. Vi prioriterer annerledes og vi investerer annerledes. Dekning av nasjonale behov og investeringer begrunnet i sitt forretningsmessige potensiale teller mer enn prestisje med stor synlighet i media.' See also: NSC, Annual Review, 2000: 'Prioritering gir gode resultater.'

[147] As a slight digression, and half in jest, it may be possible to say that the Norwegian flair for the 'down-to-Earth' approach towards utilisation of space might have gotten an even more distinct and even 'sub-Earth' or 'sub-marine' – marker in the fibre-optic cable placed between mainland Norway and Svalbard in 2003, really 'underlining' the priorities of the Norwegian space administrators.

concerns other than calculable benefits to specific societal needs. With the end of the Cold War and the collapse of the Communist block, space development all over the world faced a new economic climate. There was no longer a general support for projects of ever-growing technological ambition. Norway joined ESA at the height of optimism for European development of space technology. However, after the collapse of the Berlin Wall, the ESA budget was reduced, and in the post-Cold War period, ESA Member States were once again reluctant to finance new ventures.

The end of the Cold War influenced Norwegian space activities in different ways. The reduction of resources available for space research and technology under ESA, as well as NASA, was a potential threat to Norway's position as a supplier of space services to foreign countries. On the other hand, the restrictions on the use of the Svalbard archipelago that were imposed by the difficult relationship with the Soviet Union were loosened. In today's Norwegian space policy, an extended use of Svalbard as a unique area for space activities plays a very central role.

Also with the end of the Cold War, Russia became interested in space cooperation with other countries on an unprecedented level. For instance, in 1994 Norway was offered the purchase of SS-25 rockets, made superfluous by the disarmament agreements, for civilian use. On the other hand, it would be too hasty to dismiss all of the Cold War problems as belonging to the past. The incident of a rocket launch from ARR on 25 January 1995 having been interpreted by Russian intelligence as a hostile missile heading for Russian territory left a deep impression on Norwegian space communities. Afterwards, the event was the object of jokes and ironic remarks. The ARR staff distributed t-shirts with the inscription 'we nearly started World War III'. It was, however, a very serious affair.[148] What caused the internal Russian commotion over the rocket can only be a subject for speculation. Although procedures for pre-launch had been followed by ARR and Russian authorities had been given prior notice, it was a clear reminder that space activity still had strategic connotations, and that Norway's location, close to areas of high strategic importance, may still impose restrictions on its activities in space.

Svalbard has, to some degree, continued to be a problem area when considering space activity. Starting in the late 1990s, the Russians have given clear signals that they want to step up their efforts in the archipelago, probably as an answer to Norwegian build-up in historically disputed areas. Norwegian-Russian relations was an area of high priority for Norwegian foreign policy administrators throughout the 1990s. In 2001, Russia sent quite powerful signals that it was not pleased with the way that Norway administered the islands.[149] The Norwegian build-up of space-related institutions and infrastructure in Svalbard coincided with a new effort in the 1990s to strengthen and expand the use of the islands in different ways, especially regarding ecological topics, and for scientific and educational purposes. In 1993, a branch of the Norwegian university and college system called UNIS (the University Centre on Svalbard) was established on Svalbard.[150] The Russians saw these efforts as part of a broader strategy for gaining influence in the region.[151]

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[148] On 25 January 1995 at 06:24:08 UT, a Black Brant B XII sounding rocket was launched from the Andøya Rocket Range. The payload reached an altitude of 1364.5 kilometres before it landed in the Arctic north of Svalbard. In itself, the rocket marked a historical milestone. It was the largest sounding rocket that had ever been launched from the European mainland. Completely unexpectedly, however, the launch made news headlines all over the world and threw the Andøya range into sudden fame. The reason was a message from Russian news media that Russian armed forces had identified the rocket as a possible enemy missile heading for Russian territory. This news took an even more dramatic turn as Russian President Boris Yeltsin confirmed that he had been warned of the missile by the armed forces and for the first time had used the communication equipment in his 'black briefcase' enabling the launching of a nuclear attack. The rocket incident lacked any substantial basis. It was soon established that the rocket launched from Andøya never came close to Russian territory, and also that the Russian authorities had been given prior notice of the experiment in accordance with established routines.

[149] This had to do with the aftermath of the 'Tsjernigov' affair in April 2001 and the implementation of stricter ecological legislation concerning Svalbard by the Norwegian government. This was seen as a part of a Norwegian coordinated effort to become stronger on the Svalbard arena. Aftenposten, 4th January 2004: The article 'Ønsker Norge å presse Russerne bort fra Svalbard?' was stating: 'Russerne ser åpenbart på norsk Svalbard-politikk som koordinert og gjennomtenkt, og finner det derfor ikke tilfeldig at arrestasjonen av 'Tsjernigov' fant sted i samme periode som de nye miljøreglene på Svalbard ble vedtatt. Hensikten med alt dette antas å være et norsk ønske om å forbli alene i Svalbard-området.' For more information: FFI-fokus 1-04, *Russisk Svalbard-politikk*.

[150] www.unis.no: UNIS is located in Longyearbyen. It came into operation in autumn 1993, when its first 23 students started courses in Arctic Geology and Arctic Geophysics. The Arctic Biology programme was introduced in 1994 and the Arctic

Norway's relations with ESA have also had their share of complications. In the first years following the 1987 membership, ESA was undoubtedly viewed as the most important arena for Norwegian space activities, both in practice and policy. As economic figures for Norwegian space activities show, there was a considerable increase in the earnings related to the space sector, also in connection with membership contributions to ESA. But by 2003, the growth was not as important as hoped for. The main reason was the general decline in requirements for space-related products and services in Europe. As pertains to ESA-related industry specifically, one explanation suggested was that Norway had not succeeded in developing the scientific and industrial capacities necessary for competing in the new industrial and research-connected activities that ESA was presenting on its agenda. The different space industry segments in Norway had good use of the optional programmes during the 1990s, but had more difficulties in making use of the mandatory science programmes and the large-scale tasks related to these. Industrial tasks in the construction of the Ariane-5 launcher was the prime reason that Norway's industrial return from contracts with ESA in 1991 exceeded the 100% limit.[152]

Looking at the period 1987-2003, Norwegian space activities can be viewed as being global in nature and not explicitly focussed on ESA. In addition to important efforts and investments put into the SOHO and Cluster projects, space researchers in Norway were still involved in other forms of cooperation, including projects with the United States. In the mid-1990s, following a budgetary decrease by the Research Council for new investments in space research projects within ESA, the situation became difficult.[153] The rocket activity group at ARR, as well as the increasing number of ground stations, had to find their customers on the international market. This provided the largest earning for the space-related industry in Norway and, hence, resulted in global posturing.[154]

In addition to globalisation, Norwegian space activities became increasingly important in serving government and national communities in general, with the provision of surveillance tools and the gathering of information used for security policy, and with the administration of the oceanic areas both in terms of ecology and in resource management of fishing. The growing efforts in using Earth observation technology for providing data for societal demands have been of the greatest importance for the development of the Norwegian space sector since the 1990s, and have influenced the policies and strategies of NSC.

## The Norwegian space sector in economic figures

Space activity, in a broad sense, has been economically profitable for Norway since 1987. In the first long-term plans for Norwegian space activities, published in 1989, it was pointed out that during the last decades Norway had probably had more space activities than most other countries similar in population size and national gross product, and that this would continue to be the case in the foreseeable future. At the end of the century, NSC ventured to proclaim Norway as a 'large European space nation' relative to the size of its population.[155] By the year 2004, only the United States and France have had a higher turnover ratio per capita connected to space-related activities.[156]

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Technology programme in 1996. All the UNIS courses are based on the exceptional location of Svalbard and the pre-eminence of this region as an 'Arctic laboratory'.

[151] From the perspective of NSC Svalbard as an opportunity for space-related infrastructure was treated under an own clause in the annual reviews since 1995 The 1996 Annual Review featured an editorial with the heading: 'Space activities on Svalbard growing strongly'

[152] NSC, Annual Review, 1990: 12

[153] NSC, Annual Review, 1994

[154] In the editorial of the NSC Annual Review from 2001 the words used to describe this are: 'The European Space Agency is out cooperative cornerstone. But we have also benefited considerably from the potentialities generated in bilateral arrangements, particularly with Canada, the USA and Japan. We have used them to good advantage, as in developing leading space activities at Tromsø, on Andøya and, most recently, on Svalbard […]'.Pål Sørensen put it this way in 1995: 'Ever since Norway joined ESA as a member we have had the global markets as the goal […]'

[155] NSC, Annual Review, 2000: 1: 'Norge, en stor europeisk romnasjon'

[156] VG, 11.01.2004, 'Norsk rom-eventyr'

The growth in the space sector has been strong since 1987, but not quite as strong as was originally anticipated. Initially, NSC indicated an annual increase of Norwegian space-related products and services as well over the 10-15% average growth anticipated for in international markets. Consequently, a goal was fixed for an average growth rate, in national and international markets, of at least 15% per annum. The stipulation of a growth rate of space-related turnover at a specific level was a bold step. It reflects that the basis of NSC was a programme for making 'space' measurable, and that Norway's efforts in space were to be based on user-oriented, scientific, industrial and political considerations.[157] The first part of the 1990s marked the largest increase in annual turnover. In the first few years after 2000, international markets were in a decline, strongly affecting Norwegian business and technology enterprises. By the year 2002, the stipulated growth rate was lowered to 10%, following the general market trends.

Norway was not a newcomer to the field when ESA membership came into effect. By 1988, NSC could report that Norwegian space activity accounted for an aggregate turnover of about NOK 800 million and employed some 400 people – considerable for a small country – and activities were rapidly expanding. In 1989, the total of Norwegian space-related goods and services produced in Norway, by Norwegian companies, were significantly greater than domestic consumption, and Norway became a net exporter. By 1996, Norwegian space-related revenue had reached a total of NOK 3.2 billion. In 2002, the number of employees reached 2000, and the annual total revenue was NOK 5.1 billion, surpassing even the long-standing Norwegian forestry industry. It is necessary to keep in mind that through most of the period 1987-2003, around two-thirds of these sums were constituted by the earnings in the satellite communication segment. Telenor (ex-NTA) and NERA have accounted for the largest share of the total turnover.

Public grants for research and development related to space activities was NOK 280 million in 1989, of which 64% was committed to ESA. By 1996, the amount had increased to NOK 461 million, with 43% going to ESA. In 2003, the sum was roughly the same, with NOK 480 million for space-related R&D and 45% of this sum being paid to ESA.[158] Compared to other countries in Europe, the Norwegian R&D effort has been fairly modest, not only in connection with space activities, but also in general.[159] The fact that the relative contribution to this field has gone down during the last years is of great concern to space activity administrators, particularly at NSC.[160] The original intention for ESA membership endorsed by the Norwegian Parliament in 1987, was to increase the participation level in the optional programmes until reaching the GDP ratio. This goal has yet to be achieved.[161]

Due to limited financial resources, Norwegian participation in ESA programmes has been strictly limited according to national priorities. In spite of this, Norway was, starting in the 1990s, awarded industrial contracts for deliveries under ESA programmes that exceed the normal 'fair return' of investment. In 1991, the industrial return was 109%.[162] At the end of 1994, Norway's return represented 113%. From 1994 until 2002, the industrial return was averaging 105%. And, although Norway has not fully participated in technology development or scientific work within ESA, its industry and scientific communities have been enjoying favourable conditions in ESA since 1987, particularly during the first part of the 1990s in relation to Ariane 5 development and SOHO.

Another striking and positive feature of ESA membership in economic terms is the additional total turnover of the aggregate value of ESA contracts and coordinated support programmes, in Norway

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[157] In a report from the Office of the Auditor General of Norway submitted in 1994, NSC was given much credit for the way it had fulfilled its mandate until then. Norwegian turnover in space products and services had proved to grow more than the stipulated 15 percent annually.

[158] NLTPR, var. Vol.

[159] Forskningspolitikk 3/1995: Interview with Hugo Parr: '*-Industriens beskjedne FoU-innsats har plaget oss lenge.*'; Dagbladet, 31. December 2003, Kari Kveseth, RCN: '*Myter og fakta i norsk forskning.*' Se also: *OECD – Main Science and Technology Indicators* 2003:1

[160] A goal for Norwegian research and development at large that has been running through the years has been to bring the investments up to the OECD average.

[161] Source: The annual NLTPR and the NSC reviews.

[162] 1991 was the first year that NSC used the index of industrial return in the annual reviews.

referred to as the 'spinoff benefit factor'.[163] According to calculations presented by NSC, contributions paid to ESA during the period 1985-2004 created an additional turnover for Norwegian industry, approximately 4.1 times larger than the investments.[164]

## Institutions and infrastructure – expansions and new establishments

Between 1987 and 2002, Norwegian space-related activities experienced a growth in the number of institutions. The most remarkable was the construction of space-related infrastructure at Svalbard, namely the SvalRak and SvalSat projects.

The Andøya Rocket Range (ARR) was merged with NSC in 1987 as part of new strategies in Norwegian space policy. In 1991, the range became an independent operational unit and, in 1997, ARR was made a limited liability company, with NSC owning 90% and Kongsberg Aero & Defence 10%. Since 1987, ARR has been technologically upgraded. In 1989, buildings were added for educational purposes. In 1990, the range was upgraded for the recovery of payloads and rockets from the sea. In 1993, a new launch ramp for rockets exceeding 20 metric tons was installed.[165] In 1995, the User Science Operation Centre (USOC) was completed and, in 1995-1996, the real-time telemetry processing capacities were upgraded. In an attempt to make scientific rocket projects less expensive, the University of Tromsø in cooperation with NDRE, started a project for miniature rockets. The concept called 'Mini-Dusty' was planned and tested in the years 1996-1998 and used in the Norwegian-German MIDAS project between 1999 and 2003.

In addition to the scientific activities at the rocket range, ARR has also been used as a test range for defence and defence-industry purposes. For this, a subsidiary of ARR named the Nordic Sea Test Range (NSTR) was established. In 1999, the company entered an agreement with the Norwegian Air Force for test work that was previously done at the Andfjorden Test Range.[166]

An important new establishment organised as a part of ARR was the Arctic Lidar Observatory for Middle Atmosphere Research (ALOMAR). The first part was constructed in 1993-1994, and the whole installation was completed by the year 2000. The observatory was the result of a German-Norwegian initiative, and was financed by contributions from France, Germany, UK, USA, Switzerland and Norway. The observatory has made it possible to combine differently-instrumented rocket campaigns and ground-based measurements in atmospheric research, and studies of the ozone and other trace gases in the middle atmosphere (from 10-100 km).[167] In 1998, ALOMAR was approved by the EU as a 'Large-Scale Facility' related to the fourth and fifth framework programmes.[168]

The most important extension of ARR in the 1990s was the construction of a mobile launch site for scientific rockets at Ny-Ålesund, Svalbard, with the aim of providing unique conditions for rocket studies of the dayside polar cusp, cleft and cap. The combination of high geographic and geomagnetic latitude was recognised as being ideal for scientific exploration of the dayside aurora and processes in the

[163] The Norwegian Space Centre and an independent consultancy have jointly developed a method of assessing the spinoff benefits of Norwegian involvement in ESA cooperation. ESA cooperation as well as several other factors for assessing the effects of ESA involvement have been evolved in cooperation with the Ministry of Trade and Industry. The spinoff benefit factor is based on data provided by businesses in the space sector. It has risen steadily since Norway became a member of ESA in 1987. In 2002 the factor was four, which showed that ESA involvement resulted in additional business turnover of four times as much as the total for the ESA contracts involved.

[164] NSC, Annual Review, 2002: 2

[165] The first project recovering the payload was the Norwegian-German TURBO project in January 1990. The first launch from the new ramp, the U3, was in January 1994.

[166] ARR made an agreement with the Norwegian armed forces in 1992 on establishing the Andfjorden Testbane (ATB: Andfjorden Test Range). NSC, Annual Review, 1992: 14. NSTR is also called Andøya Test Centre (ATC).

[167] The first lidar at ARR was installed by a research group from Bonn University in 1984, and the ideas for the ALOMAR was conceived inn a cooperative effort between representatives from Bonn, ARR and NDRE in 1991. The cornerstone was laid in the summer of 1993, and the Observatory was opened on June 16th 1994. By 1999 50 scientific articles had been produced related to ALOMAR, of these 1/3 had Norwegian co-authors.

[168] 4,3,2,1, FIRE! Historien om Andøya Rakettskytefelt, ARR 2000: 90

magnetospheric boundary layer.[169] The planning of the launch site started in 1993, and the installation, SvalRak (*Svalbard Rakettskytefelt*), became operational in November 1997. Since then it has served research groups from both Germany and Japan. In the late 1990s, ARR was able to increase its share of the globally decreasing market for sounding rocket launches. This mainly resulted from the SvalRak Station at Svalbard and the synergies related to the use of ALOMAR coordinated with the range.[170]

During the 1990s, educational activities at ARR also grew steadily in significance. Since 2000, the National Centre for Space-related Education (NAROM) has been an important institution in the strategic and future investment for Norwegian space education activities.

In addition to the extension of ARR to Svalbard, the EISCAT range of facilities in the Nordic countries was extended to the archipelago by establishing the EISCAT-Svalbard in 1994. Subsequent upgrading in 2000 and 2002 was mainly due to Japanese research groups joining EISCAT.

The Tromsø Satellite Station was merged with NSC in 1990. This was the result of a political desire and need to make TSS profitable after a period of decreasing activities and income.[171] In 1991, TSS was upgraded to meet the needs for serving the ERS-1 satellite, as part of Norwegian efforts in, and the use of, Earth observation.[172] In 1995, TSS was separated from NSC as a joint stock-holding company owned by NSC and the Swedish Space Corporation. Under the new 50-50 Norwegian-Swedish ownership, the firm was intended to turn into a market-oriented sales organisation in the expectation of a growing market for Earth observation data. During the same year, TSS entered an agreement concerning telemetry services for the Canadian Radarsat satellite and, subsequently, underwent substantial technical upgrading.[173] Starting in 1996, TSS gained a key role in the construction and operation of SvalSat.

The largest and most important investment in Norwegian space-related infrastructure during the 1990s was the construction of a satellite station at Svalbard. The station was intended to serve meteorological and Earth observation satellites in polar orbits, with the distinct advantage of being able to track all (14 of 14) orbits of such satellites. The idea for the installation emerged during the early 1990s, and construction planning of the station started in 1995. Platåberget, 450 meters above Longyearbyen, was chosen as the site for the station. The first phase of construction began in 1996, leading to experimental operations in 1997, under a cooperative agreement between NSC and NASA. In 1998, NASA expanded its activities at SvalSat by installing the NASA Isbjørn Facility serving satellites connected to the large-scale project 'Mission to Planet Earth'. During the same year, Lockheed-Martin and Kongsberg Spacetec entered a cooperative effort to make SvalSat one of the leading satellite stations in the world and established the Kongsberg Lockheed Martin Space Data Services (KLMSDS). SvalSat was officially opened in September 1999. Operations serving the Landsat 7 satellite had already started earlier the same year. In 2000, SvalSat made a breakthrough by being chosen by Eumetsat to become the main ground station for the Metop satellites. This choice was beneficial for Norwegian firms which gained yet more contracts, and for the consideration by the National Oceanic and Atmospheric Administration (IPO/NOAA) to make SvalSat a main station for the downloading of satellite data. In 2001, NRSE acquired Lockheed Martin's 50% share in KLMSDS. In connection with an agreement (negotiated in 2002 by NSC) for the purchase of the Swedish Space Corporation's 50% share in TSS, an equally-owned joint company, Kongsberg Satellite Services AS (KSAT), was setup between Kongsberg Defence & Aerospace and NSC. Its purpose was to integrate the activities of TSS, SDS and the Svalbard part of the NRSE.[174]

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[169] Rocket studies of the dayside polar cusp, cleft and cap can be carried out using smaller and less expensive sounding rockets. In particular, sounding rockets can be launched directly into the polar cap and they can be launched along and perpendicular to the Earth's magnetic field.
[170] NSC, Annual Review, 1998: 4.
[171] NSC, Annual Review, 1991: 4, TSS which had been upgraded at a total cost of some NOK 100 million, had problems positioning on the markets. Established as an independent foundation in 1984, it merged with NSC after the writing-off of debts.
[172] NSC, Annual Review, 1991: 4, 12
[173] NSC, Annual Review, 1995: 3
[174] NSC, Annual Review, 1995: 2

By 2002, ESA was using SvalSat for its ERS-2 Earth observation satellite and for its environmental satellite, Envisat, making SvalSat the world's leading station for the operation and downloading of data from polar orbiting satellites. In 2003, financing provided by SvalSat's biggest customers, foremost NASA and IPO/NOAA, made the construction of a fibre optic cable for high-speed communication with mainland Norway possible, further strengthening the station's position on the world market.[175]

## Developments in space-related industry in Norway since 1987

The number of industrial groups and manufacturers of space-related technology operating in Norway has grown since Norway became an ESA Member State. In 1987, 15 companies were active in this sector. By 2002, it was estimated that some 40 companies and institutions had a share in space sector trough contracts for technological or infrastructure development, or in various other forms of cooperative agreements.[176] The most significant firms in terms of turnover in the period 1987-2003 include Telenor, NERA, Tandberg Television, the different subsidiaries of the Kongsberg-group (such as Kongsberg Defence and Aerospace, Kongsberg Spacetec, and Seatex) and AME Space (Alcatel Space Norway). All through the 1990s and into the first years of the 21st century, satellite-based telecommunication has been the major area of business for Norwegian companies, consistently acquiring two-thirds of the total Norwegian space activities revenue.

*Telenor* is, to date, one of Norway's largest companies. The company changed its name from *Televerket* (NTA) to Telenor in 1995, after having become a public corporation in 1994. This was a continuation of the developments in Norwegian telecommunication markets, which were opened for full competition in 1998, followed by Telenor becoming partly privatised in 2000.[177] During the 1990s, the company's different divisions made several strategic acquisitions in the satellite telecommunication market, amongst these the 'Thor' 1-3 satellites.[178] In 2000, Telenor bought a block of Lockheed-Martin's shares in Inmarsat, and thus became the largest single shareholder. The next year, Telenor Satellite Services purchased Comsat Mobile Communication from Lockheed-Martin and, consequently, Telenor also became one of the world's largest operators in satellite mobile communication.[179] Telenor is also the fourth largest shareholder in Intelsat.

NERA has for a long time been the largest supplier of space-related systems in Norway. During the last decade, NERA has developed into one of the most important Norwegian exporters. More than 90% of NERA's sales derive from international markets. NERA's activities have been satellite communication systems for the ground segment. After a merger with Elektrisk Bureau, a part of the company's telecommunication activities were, in 1986, consolidated under the name EB NERA, later ABB NERA.[180] The company led the market for Inmarsat solutions in the late 1980s. In 1995, it was once again established as an independent company under the name NERA, and introduced on European and US stock markets. One of the company's biggest successes has been the Saturn mobile ground stations (for Inmarsat services) which have been manufactured since 1978. NERA has also become a recognised authority on research and development in wireless communication technology. The introduction of mobile telephony and the deregulation of the telecoms sector in many countries were developments that gave NERA Transmission its final international breakthrough.[181] In 2002, a new subsidiary, NERA Broadband Satellite, which develops and markets terminals and ground stations for broadband satellite systems, was awarded major contracts with operators in Europe and southeast Asia. By 2004, NERA SatCom has become the global market leader (40-50%) in mobile satellite communication. The company

[175] NSC, Annual Review, 2002: 3
[176] The Norwegian Space Centre, *Long term plan for Norwegian space activities*, 2002-2005
[177] Telenor had 2003 revenues of approximately NOK 53.1 billion (approximately U.S. $7.6 billion) and a workforce of 22,100 located in Norway and abroad.
[178] In 2001 Telenor abandoned its plan to buy a Thor-4 satellite.
[179] NSC, Annual Review, 2001: 6. Telenor Satellite Services owns and operates a global network of ground stations located at Eik (Norway), Southbury (Connecticut) and Santa Paula (California) in the U.S., and uses the satellite systems of Inmarsat, Intelsat, Iridium, New Skies, Satmex, Spacecom, and also on Telenor's own satellites for its services.
[180] In 1977, Elektrisk Bureau bought Nera, and, after the acquisition, focused its telecommunication activities on L.M Ericsson's products in Norway, as well as the development, production, marketing and sales of its own products.
[181] In the early 1990s, Nera established itself as one of the worlds leading suppliers of high capacity radio link (SDH).

also delivers Inmarsat ground stations and super ViSat – stations for systems operating on the Intelsat, both off-shore and general telecommunication, services.

Tandberg Television has developed, manufactured and marketed leading, open-standard digital broadband solutions for broadcasters, cable companies, satellite operators, terrestrial-based companies and telecommunication companies. The company has delivered equipment for most of the world's major satellite systems.[182]

AME Space, renamed Alcatel Space Norway in 1999 and then again AME Space in 2004, has been the only Norwegian company entirely devoted to space products. It was established in 1986 following a split-up of Aker Mikro-Elektronikk (AME).[183] In 1989, Alcatel STK and Alcatel Espace bought 60% of the company; in 1996, Alcatel gained total ownership. An important breakthrough for the company was ESA's decision to allow AME Space produce the Chirp generator for the radar altimeter on ERS-1, and later the company received a similar contract for ERS-2.[184] Another important milestone was in 1989 when AME Space was awarded the contract for power distribution units, level conditioners and parts of the guidance electronics for the Ariane 5 launcher. These contracts opened the possibility for continued deliveries to the Ariane 5 programme for as long as 15 to 20 years after the initial development of the products.[185] In the 1990s, AME Space received important contracts for the delivery of IF processors, including SAW channel filters, for several satellites including Aramis, EMS, Artemis, Radarsat, Solidaridad, NSTAR, MTSAT and MSG. The most important milestone achieved by AME Space was in 1995 when the company was chosen as the supplier of SAW filters to the Globalstar mobile satellite communication system. This breakthrough established AME Space as a world leader in its niche. Continued contracts followed for ACeS, and AICO. In 1999, the company was awarded an important contract for the TRW-Astrolink broadband system. AME Space changed its name to Alcatel Space Norway (ASN) in 1999, following a merger between Alcatel Espace, Thompson satellites and Aerospatiale in 1998. During the years 2000-2001, ASN had contracts with all of the 6 major global satellite contractors, underscoring its position on the world market.[186] After 2001, ASN met with problems as a result of the general market decline. In 2003, Alcatel Space closed down on financial grounds. This was a fierce blow to Norwegian space industry, and evoked the old question: to what extent Norway should or would be able to uphold specialised space-related technology.[187] During the autumn of 2003, efforts were made to continue activities in Horten. A few of the key employees bought the firm and reopened in January 2004, again under the name of AME Space.[188]

The Kongsberg consortium (*Kongsberg Gruppen*) grew during the 1990s to become an international technology corporation headquartered in Norway, with over 4000 employees in more than 20 countries and with a focus on two business areas: maritime technology, and defence and aerospace technology. The company originated as *Kongsberg Våpenfabrikk* (KV: Kongsberg Weapons Factory) and was restructured in 1987 when all civilian activities were sold. Defence activities were continued under the banner of *Norsk Forsvarsteknologi AS* (NFT: Norwegian Defence Technology), which formed the basis of the later corporation, *Kongsberg Gruppen*. Together with its wholly-owned subsidiaries, Spacetec AS and *Informasjonskontroll*, the NFT was one of the largest suppliers of space products in Norway in the 1990s.[189] After 1989, the NFT devised a strategy involving more attention to civilian markets.[190] An

[182] www.spacecentre.no
[183] Later, from 1989 onwards, a part of the original AME has also had contracts concerning satellite technology development.
[184] Nytt om Romfart, NAF, nummer 76, oktober-desember 1990: 150-151, 'Eksursjon til AME Space'
[185] In addition, AME Space had produced components for the Scandinavian telecommunication- and broadcasting satellite Tele-X, launched in 1989, an effort on a smaller scale.
[186] Amongst these were: Lockheed Martin (GE Americom), Alcatel and Space Systems/Loral (MSAT-1R), Astrium (for Inmarsat IV)
[187] This was a concern particularly aired by NIFRO. NIFRO made a comment on its homepage on the press release from the Alcatel Corporation on the 25. April 2003, saying that this was evidence that the Norwegian policy of not taking strong enough advantage of the optional programmes in ESA was hurting Norwegian space industry.
[188] Interview with Øivind Andressen, AME Space, 10. march 2004
[189] *Informasjonskontroll* was an important supplier of advanced SAR processors, including software and hardware for near real-time processing of SAR data from Earth observation satellites at TSS. Together with Cap Computas, Informasjonskontroll received in 1989 an important contract for developing a ground software system for Columbus which is called Verification,

important breakthrough for the NFT occurred in 1991 when the company was awarded a contract for the design and development of the booster attach and separation mechanism for Ariane 5. In 1993, the NFT received another important contract for MIPAS, an instrument used on board Envisat.[191] The company was listed on the Oslo Stock Exchange in 1993, and changed its name to *Kongsberg Gruppen* in 1995.

Founded in 1984, Kongsberg Spacetec AS has become one of the leading producers of receiving stations for data from meteorological and Earth observation satellites (optical and SAR). Its products, including the MEOS (Multi-mission Earth Observation System), have been delivered to a number of clients around the world. Located in proximity of the Tromsø Satellite Station, Kongsberg Spacetec has specialised in the delivery of Earth observation ground stations.

Kongsberg Satellite Services (KSAT) was formally established on 1 February 2002 as the continuation of the former Tromsø Satellite Station (TSS). The activities of the joint venture company Kongsberg Lockheed Martin Space Data Services, operative since 1998, were transferred to KSAT in 2002. The owners of KSAT are Kongsberg Defence and Aerospace (KDA) and NSC each with a 50% holding.[192] The main business areas for KSAT are ground station services such as telemetry, tracking and control (TT&C), global data dump and near real-time acquisition, and the processing of Synthetic Aperture Radar (SAR) data and related services. KSAT is in the unique position to offer operational services for all polar orbiting passes due to the high latitude of the TSS and SvalSat ground stations.

Kongsberg Seatex is a leading international marine electronics manufacturer specialising in the development and production of precision positioning and motion sensing systems. It is actively involved in the manufacturing of integrity systems for Europe's EGNOS programme in cooperation with the Norwegian Mapping Authority.

Raufoss Technology AS (NAMMO Raufoss) entered space with the manufacturing of different valves and structure parts for Tele-X in 1986, followed by the development and manufacture of Star Tracker Baffles for ISO in 1991. Also in 1991, Raufoss received important contracts for the delivery of joint, struts, check valve, safe and arm mechanisms and the booster separation motors for the Ariane 5 launchers.[193] From 1992 to 1999, Raufoss specialised in developing different types of valves for liquid propulsion systems for ESA, in cooperation with ESA's technology centre ESTEC.[194]

A space industry project involving a Norwegian company, not directly connected to NSC, that should be mentioned, is Sea Launch. Formed in 1995 as a joint venture between Boeing Commercial Space Company, two Russian companies, *RSC Energia* and *SDO Yuzhnoye/PO Yuzhmash*, and the Norwegian shipbuilding and engineering company *Kværner*, the firm attempted at constructing and operating a seaborne rocket launcher using Russian rockets and converted oil rigs. The idea behind the sea launch facility was a more cost-efficient alternative to land-based launches, as well as the advantage of being able to move almost everywhere on the Earth's surface in a relatively short time to exploit the most favourable launch windows. The idea for a flexible and mobile launcher facility at sea was proposed in the early 1990s, and was formulated in response to increased market demand for a more affordable and reliable commercial satellite launch service. During a span of five years, the Sea Launch partners built the launch infrastructure and operating launch system. The first demonstration launch took place in March

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Integration and Check Out Software (VICOS). This system is now being delivered both to ESA and other important customers such as Boeing and NASA.

[190] In the 1990s, several strategic acquisitions were made in the maritime electronics and systems sector. Considerable organic growth was achieved in maritime and defence activities alike. Consolidated operating revenues expanded from MNOK 581 in 1987 to MNOK 6 980 in 2002. During the same period, the staff increased from 2 335 to 4 208 employees.

[191] This contract included the design, development, qualification and production of the Optical Difference Subsystem and was performed together with *Norsk Elektro Optikk AS*.

[192] By the year 2004, KSAT has 48 employees and operates 2 ground stations in Tromsø (69N) and at Svalbard (79N).

[193] The booster separation motor involves not only Raufoss experience in rocket motors but also its advanced competence in special aluminium alloys. Because of this, Raufoss was able to design the booster rocket separation motor in aluminium, instead of steel, which would otherwise have resulted in a much heavier and more expensive motor.

[194] Development of new advanced aluminium or dispersion strengthened aluminium (DS-AL) resulted in contracts to ESA's FESTIP programme 1995.

1999, and the first commercial launch, DIRECTV 1-R, in October the same year. The Sea Launch project has had its share of trouble in the process of planning and testing, but the contracts obtained by the company during the last few years may yield profits in the years to come.[195] It is common knowledge that the current Kværner (now Aker Kværner) management wants to pull out of the Sea Launch venture as soon as a purchaser is found willing to refund at least some of Kværner's outlays.

## Norwegian space science and research projects since 1987

The groups undertaking space research in Norway during the period 1987 to 2003 were mainly located at the universities in Oslo, Bergen and Tromsø, as well as NDRE and some regional colleges. Scientific activities were coordinated with ESA, ARR and SvalRak (using EISCAT and, eventually, the EISCAT-Svalbard radar), and, to some extent, with the Nordic Optical Telescope. The technological tools have been: instruments on board satellites, particularly in the ESA context; instrumented sounding rockets, continuing the work done at ARR through the decades; and scientific balloons, an activity that gradually diminished as a Norwegian area of priority but was continued on Norwegian soil by French research groups. During the 1990s, sounding rocket activity was complemented by the use of different ground-based measuring technology such as LIDAR, incoherent scatter radar and, eventually, small-scale rockets, giving a new push to the studies of the middle atmosphere with the use of fairly low cost tools.

During the initial period after ESA membership, the main strategy for Norwegian space research was to focus on ESA programmes in accordance with the cornerstones of the 'Space Science Horizon 2000' programme. These were programmes in which Norway would be able to contribute and Norwegian research workers would on the leading edge.[196] In 1989, the main strengths of Norwegian space research were found in astrophysics, particularly solar- and stellar-physics, cosmology and space physics, where Norwegians specialised on studies of the upper atmosphere and the magnetosphere. In addition, there was a small, but very active group in bioscience focusing on plant physiology at the Norwegian Technical University in Trondheim.[197]

Norway also gave attention to projects related to ARR and bilateral projects outside of Europe (e.g. in cooperation with NASA).[198] Although, Norwegian participation in ESRO/ESA satellites was precluded for many years, cooperation was established with foreign groups in the satellite, sounding rocket and balloon programmes. Norwegian scientists were invited to participate in experiments on NASA spacecraft – Spacelab 1, IMPS, NOAA-13, CRRES and POLAR, as well as on the Swedish satellite projects Viking and Freja.[199] Consequently, the Norwegian space research community did not start from scratch when Norway finally joined ESA. Active Norwegian groups were already involved in experiments on the SOHO and Cluster projects. Participation in these projects, especially SOHO, were by far the most extensive Norwegian engagement in space research programmes ever, and were golden opportunities for individuals, groups and institutions in Norway to excel in areas where national traditions and skills were strong. In the early 1990s, Norwegian groups also participated in preparatory work for the Cassini/Huygens project and the Auroral Imaging Observatory (AURIO), though to a lesser extent in comparison to SOHO and Cluster.[200]

Launched by NASA in December 1995, the Solar and Heliospheric Observatory (SOHO) was the largest scientific project Norwegian space researchers had ever been engaged in. Still, Norway was a small contributor, providing only 1% of the total budget. Norwegian scientific participation was mainly

[195] Nytt om romfart, nr 107: 'Sea- Launch – brikkene faller på plass', nr 109: 'Første oppskytning nærmer seg for Sea-Launch', nr 112, 1999: 'Første kommersielle oppskytning med Sea-Launch'.
[196] NSC, Annual Review, 1988:5
[197] NSC, Annual Review, 1989:14
[198] NSC, Annual Review, 1989:14
[199] The engagement in the PICPAB investigation on SPACELAB 1 and on IMPS grew out of NDRE's electron beam and plasma experiments on sounding rockets. The engagement in VIKING and CRRES was based upon University of Bergen's experience with electron and ion spectrometers on sounding rockets and on the ESRO I satellite. Similarly, the NOAA-13 and POLAR engagements grew out of University of Bergen's auroral X-ray expertise from balloon and sounding rocket experiments. Similarly the University of Oslo's engagement in FREJA was based on their expertise from sounding rocket experiments.
[200] NSC, Annual Review, 1990:14

represented by researchers from the Institute for Theoretical Astrophysics (IFTA) at the University of Oslo. IFTA was responsible for the EGSE and operational computer systems for the Coronal Diagnostic Spectrometer (CDS) instrument. This work was done partly in-house and partly with an industrial contract for the flight model by Kongsberg Spacetec. In addition, important deliveries were made by AME Space, Kongsberg Aerospace and Det Norske Veritas.[201]

Astrophysics in Norway during the last 40 years has focused largely on solar and stellar physics.[202] Norwegian research concentrated on the study of the structure and dynamics of solar and stellar atmospheres. Particular attention has been given to solar activity, especially sunspots and solar prominences. Until the advent of SOHO, the astrophysical use of space instrumentation in Norway mainly revolved around data made available from PI instruments, from missions like Skylab or the International Ultraviolet Explorer (IUE). One important exception to this pattern was the active engagement in the operation, data reduction and analysis of the Naval Research Laboratory instrument called High Resolution Telescope and Spectrograph (HRTS). This instrument has flown several times on sounding rockets and on the Spacelab 2 mission on board the NASA Space Shuttle. The Institute of Theoretical Astrophysics developed a full-scale photometric laboratory and data reduction facility for these observations. The experience gained through the participation in the HRTS programme created the basis for the strong Norwegian participation in the SOHO mission. The use of space instrumentation for astrophysical research started at IFTA, later followed by groups at the Universities of Tromsø and Trondheim.[203]

SOHO proved to be a Norwegian success story scientifically, as well as technologically, challenging. It also served to legitimize the economic contributions by providing the media and the public with sharp and fascinating images of the Sun. Considering the context of public relations, SOHO has given Norwegian space administrators what they needed to justify the participation in such large-scale projects, at least to the general public. On the scientific side, few, or no, other large-scale scientific projects in Norway can be said to have reached the same degree of success. Summing up the Norwegian efforts in the SOHO project in 1997, NSC was particularly pleased with the way that scientists from IFTA had been able to contribute to the number of papers produced, by far exceeding what the modest Norwegian financial contribution would indicate.[204] The explanations for this success are many, but one key reason is the fortunate combination of the will to invest in space science in the second half of the 1980s and the strong scientific traditions in astrophysics and solar science built-up at the University of Oslo through many decades.[205]

Cluster (I), on the other hand, was initially not such a sunny story due to the explosion of the first Ariane 5 in June 1996 with the Cluster satellites on board. This accident put ESA in a critical state and led to questions being raised in Norway about the value of participating in large-scale projects such as these.[206]

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[201] NSC, Annual Review, 1995: 13

[202] This priority was set through the late Professor Rosseland's effort to establish the *Oslo Solar Observatory*. This facility, helped educate and train three generations of solar physicists. This concentration of effort also contributed to make the Institute of Theoretical Astrophysics, University of Oslo a well-known and respected institute within the field of solar physic. By 1986 increasing Norwegian participation in space projects as well as the availability of data from high quality ground-based observatories both in the U.S. and on the Canary Islands prompted the closing of the Oslo Solar Observatory.

[203] In particular they have concentrated on databases from X-ray satellites – EXOSAT ROSAT – and the observational use of the IUE satellite.

[204] NSC, Annual Review, 1997: 13, In a book summing up the results between 1995 and 1997, 13 out of 43 papers had contributions from Norwegian authors. By the year 1999, 2 out of the 5 scientific personnel engaged at the SOHO operations centre were Norwegian.

[205] For more on this see: Ole Anders Røberg: *Vitenskap i krig og fred : astrofysikeren Svein Rosseland i norsk forskningspolitikk 1945-1965*, Forum for universitetshistorie, Universitetet i Oslo, 2001, or Randi M. Holtungen: *En motvillig nasjonsbygger : Svein Rosseland og innføring av forskningsrettet arbeid ved Universitetet i Oslo*, Main thesis in astrophysics, UiO, 2004.

[206] In Norway, on state broadcasted television, on the 4th June 1996 the public could witness Norwegian space researchers celebrating the launch of the new European main freight rocket ready to salute with champagne and cake. When the launcher exploded and disintegrated most jaws dropped to the ground, and although it did not directly point towards problems within the Norwegian space science milieus, it was a unfortunate public display of failure that obviously was not very welcome amongst the researchers that already were experiencing a more difficult situation on obtaining support and funding for space science in the presence of the governing politicians and institutions. Views on the cost efficiency of participating on large scale projects had been questioned around the time of the Ariane 5 mishap in June 1996.

When new testing of Ariane 5 started and a decision was made to rebuild the Cluster satellites was taken within the ESA community in April 1997, Norway chose to join the initiatives and, in time, became an eager advocate for the re-launch of the project. The Cluster II satellites were launched in July and August 2000, and the full science operations of Cluster commenced in February 2001. 18 different countries contributed with on board instruments, Norway being one of the four largest.

Norwegian institutions involved in the Cluster II project were NDRE, the University of Bergen and the University of Oslo. The Research Council of Norway gave the economic support for the Norwegian part of the project. The University of Oslo contributed with both hardware and software to the Electric Field and Wave (EFW) instrument on board the satellites. NDRE designed the high voltage unit and the control electronics for the ASPOC instrument (Active Spacecraft Potential Control) and contributed to the PEACE instrument (Plasma Electron And Current Experiment).[207] PEACE was built as a cooperative project between science groups in England, France, Norway and the United States. The Department of Physics at the University of Bergen developed and delivered microelectronic circuits for the management and processing of data from the Rapid instrument.[208]

Cluster science in the participating Norwegian groups has been centred around studies of processes in the magnetospheric cusp, and on studies of substorms and storms. The four-spacecraft configuration is particularly well suited for such studies. NDRE is involved with two experiments on Cluster II, one for the emission of ions to control the electric potential of the spacecraft and one for measuring electrons from energies of eV to keV. The University of Bergen participates in a high-energy ion/electron experiment and the University of Oslo in an electric field experiment which is part of a large field and wave combination. The combination of observations on Cluster, from the ground (e.g. EISCAT and optical observations), and on SOHO, POLAR and other satellites, have been expected to contribute significantly to solar-terrestrial science. Increased data coverage for the Cluster satellites gives more cases for multi-instrument studies combining spacecraft and ground-based observations.

For Norwegian rocket researchers, cooperation with German research groups was especially fruitful in the 1990s. In 1990, the TURBO project was undertaken by groups in Oslo and Bonn and, for the first time, payloads were recovered after falling to the sea. Involvement in other international projects also became very important, such as the DYANA campaign in 1990.[209] In addition, Japanese research groups used both ARR and, subsequently, SvalRak, for wholly Japanese sounding rocket campaigns. A scientific rocket launched from ARR in 1990 was the first Japanese rocket to depart from European soil. The ECHO campaign in 1994 was coordinated with the use of the ALOMAR installation, and was the first step towards an integration of ground-based measurements and sounding rocket launches.[210]

In the period 1962-1987, a total of 426 meteorological and instrumented rockets and 159 scientific balloons had been launched from ARR. In the period from 1987-2000, 272 scientific rockets were launched and, additionally, 12 rockets from Lista and 4 from SvalRak.[211] In the mid-1990s, experiments with small-scale rockets, the 'Mini-Dusty' concept, proved that these kind of payload carriers could very well serve specific purposes.

The latest large rocket campaign from ARR was the MIDAS project. MIDAS was a continuation of several joint projects through 15 years between German and Norwegian research groups. Through this long-term cooperation the scientific groups in question have been able to attain a leading position in the world on the exploration of the middle atmosphere (80-120 km). MIDAS successfully carried out its first launches from ARR in the summer of 1999, and ended during the summer of 2003.

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[207] The EFW instrument measures electric and magnetic fields. The ASPOC instrument neutralises the satellite by sending out a flow of positive charged particles. PEACE is measuring electrons and is giving important information about the current systems of the electrical charged gases in our near space.

[208] The group at UiB has also built and delivered equipment, including software, for the testing of the instrument.

[209] 4,3,2,1, FIRE! Historien om Andøya Rakettskytefelt, ARR 2000: 81

[210] 4,3,2,1, FIRE! Historien om Andøya Rakettskytefelt, ARR 2000: 75, TURBO: *TUrbulens Bonn Oslo*. Later the MACERATE and TROLL campaigns in 1997-1998 were carried out in a synchronised effort with the ALOMAR

[211] 4,3,2,1, FIRE! Historien om Andøya Rakettskytefelt, ARR 2000: 88

The use of scientific balloons has been chiefly performed by groups from the University of Bergen in order to study magnetospheric phenomena. In the first part of the 1990s, balloon-based research in magnetospheric physics gradually became dormant as a result of the shift towards satellite-based measurements.[212] But, there was a steady use of scientific balloons from ARR by CNES during the 1990s.

In the mid-1990s, NSC tried to coordinate Norwegian groups participating in the XXM and Integral projects, but these efforts did not pay off in the same manner as the SOHO or Cluster projects. The trouble with coordinating the Norwegian effort towards new projects in ESA has been seen as part of a larger problem for the Norwegian space sector. This has led some key players ask whether there is a decline in Norwegian space research in the new millennium. In the late 1990s and the first years of 2000, Norwegian space activities had mixed experiences. In 1994, it was realised that national financial support for the scientific utilisation of ESA membership had become insufficient in relation to the demands for participation in new projects.[213] During the rest of the 1990s, this continued to be a constant source of worry, particularly for NSC. According to one strong view presented by Bo Andersen, of NSC, research and science in space efforts have been given less priority, and have not benefited from their position between NSC and the Research Council.[214] A differing viewpoint holds that there is a need to prioritise the use of financial resources for space science against a national, as well as an international, basis. This is the line of argumentation by the Research Council.[215] The debate on how much money can be spent is a familiar one; it recurred in the mid-1990s and was particularly accentuated following the advent, in 1993, of one national research council, the Research Council of Norway (RCN).

The basic science programmes of NAVF and later RCN were crucial for Norway to take advantage of investments in projects such as SOHO, NOT, EISCAT and, later, Planck. But, the budgetary size of these programmes significantly decreased after 1987. In 1991, the national resources for the utilisation of the science programmes in ESA constituted 46% of the contributions to ESA. In 2002, it had been reduced to about 15%.[216] Cutbacks on financial support from the Research Council made NSC persistently comment on the matter during the 1990s, arguing that this would only restrain Norwegians in relation to their international competitors and collaborators.[217]

The 'big science' problem had thus resurfaced as a general problem for Norwegian research with its small communities and scarce resources. In 1999, the RCN programme for space science, ROMFORSK, was terminated. This added to the insecurity of Norwegian research groups, but the work was extended through ad-hoc arrangements. In the first years of the new millennium, initiatives were made for a new space science programme, called ROMFORSKNING. In 2000, RCN carried out a review on Norwegian physics research.[218] In general, space physics was one of the areas seen to be successful.

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[212] During the period 1974-1991, balloon observations of the precipitating electrons gradually were coordinated with in-situ satellite measurements of magnetospheric particles and fields, culminating with the SBARMO-79 programme. This programme, carried out as a part of the International Magnetospheric Study (IMS) by a consortium led by the University of Bergen, coordinated investigations of dynamical processes in the magnetosphere with special emphasis on substorms. Balloon flights were coordinated with the operation of particle and field instruments on the geostationar,y satellite GEOS 2. The balloon payloads contained instruments to measure X-rays, electric and magnetic fields, and VLF waves, some also provided observations of the spatial structure of the electron precipitation. The ensuring scientific analysis has focused on investigations of magnetospheric substorms processes and the connection between plasma in the near-Earth magnetotail region and in the auroral zone ionosphere.

[213] NSC, Annual Review, 1995

[214] Bo Andersen, of NSC, spoke his mind in an interview in the research policy magazine Forskning 1/2003, saying that Norwegian space science and its future was in a worrying state, mostly resulting from the lack of will in the Research Council to support scientific projects into ESA.

[215] 'Forskning', nr. 2, 1995: 'ESA fokuserer på nye forskningsområder.' Kari Kveseth, områdedirektør i Norges Forskningsråd, uttalte seg i 1995 i bladet Forskning (nr 2, 1995) at det var nødvendig å ha en debatt om 'de betydelige midler Norge I dag bruker på det samlede engasjementet internasjonalt.'

[216] NLTPR 2003-2006, NSC 2003: 17

[217] NSC, Annual Review, 1995: 4

[218] Physics Research at Norwegian Universities, Colleges and Research Institutes – a review (2 volumes), the Research Council of Norway, 2000

Summed up, there are both challenges and opportunities for the Norwegian space research sector in the near future. One of the challenges will be to try to get various bodies, like RCN, NSC, and government representatives, to work together towards coherent science policy strategies for Norwegian space science. Efforts to create such concord were purportedly initiated in the spring of 2004. One sign of this was the publication of a newspaper article in May 2004, co-authored by Bo Andersen (NSC) and Roy H. Gabrielsen (RCN) which strongly emphasised the need for a joint working relationship in space-related science.[219]

## Education and recruitment in the Norwegian space sector

Another important challenge for the Norwegian space sector is the need to secure the succession of scientific and technological talent for the future development of space activities. The increasing concern for the recruitment of new personnel from the late 1980s to 2003 was met by various initiatives to establish educational programmes and to upgrade institutional capacity. The endeavours dealing with education issues started in the late 1980s; a main thrust was given in the late 1990s and efforts have again increased since 2000.[220]

In 1989, a programme for cooperation in space-related education started at Andøya. This was the result of an agreement between ARR and a local high school (Andøya Videregående skole). A 'space technology course' was initiated as a stepping stone for further studies in space technology at higher levels of education.[221] During the same year, an agreement was made between NSC, the Norwegian Technical University and other universities to begin planning for educational opportunities in space-related science and technology subjects at the doctorate- and post-doctorate levels. A first test course was held in August 1990 and continued annually throughout the decade.[222] In 1994, a course aimed at teachers at the high school level was provided.[223] In 1996, NSC participated in setting up space-related education as part of the newly created UNIS (University Studies in Svalbard).[224]

In the early 1990s, an important initiative for space education emerged from the younger generations of Norwegian scientists. This initiative led to the establishment of a 'Space Camp' for students interested in space activities.[225] In 1996, the first Space Camp was held at ARR and attracted students from all the Nordic countries. It was considered a success and led to further development of the concept. In 1998, Space Camp organised a rocket launch. In 2000, contact with ESA was made to start the process of transforming Space Camp into an international event. The first international space camp, involving participants from outside the Nordic countries was held in 2001. From 1996 to 2003, Space Camp has had 159 participants from 12 countries.[226]

The *Nasjonalt senter for romrelatert opplæring* (NAROM: Norwegian Centre for Space-related Education) was officially opened in 2000 and new facilities housing classrooms were finished. NAROM's mandate was to organise space education, ensure recruitment opportunities, promote appreciation for the benefits of space activities and to stimulate the interest for science in general. Its goal has been to initiate, develop, and perform educational activities, seminars and conferences at all levels within subject areas related to space, such as space technology, space physics, the atmosphere and the environment. NAROM is co-located with ARR, is subject to coordination from NSC, and has been partly sponsored by the Norwegian government. It entered into agreements to cooperate with major research and

[219] Aftenposten, 10. may 2004: 'Norsk romforskning: Vi tjener på å satse sterkere', by Bo Andersen and Roy H. Gabrielsen.
[220] The term 'Education' was treated under an own clause in the 1989 Annual Review from NSC, but the following years it was seen mostly as a part of the activities at ARR. This may indicate, albeit not strongly, something concerning the perspectives of the administrative apparatus within NSC on this topic.
[221] NSC, Annual Review, 1991: 15, The first pupils were graduated from a two year course in 1990.
[222] NSC, Annual Review, 1989: 15
[223] NSC, Annual Review, 1994: 14
[224] NSC, Annual Review, 1996
[225] In 1994 Gustav Frisholm from the Norwegian Association of Young Scientists (FUF) participated in NORNA, a science summer camp in Sweden, and got the idea of making a similar camp in Norway. The next year, in 1995, FUF contacted Arne Hjalmar Hansen, then newly employed education manager at Andøya Rocket Range, and discussed the possibilities of organising a science camp at Andøya.
[226] The organisers are currently (2004) ESA, NSC, NAROM and FUF.

educational institutions in Norway, including all universities and most regional colleges, serving as a school laboratory and field station in space-related disciplines. In addition to national networks, NAROM is associated with EURISY and the ESA Education Office.

The Internet has, since the mid-1990s, become an important tool for educational tasks, recruitment efforts, and maintaining the necessary public relations. A Norwegian space website called SAREPTA was developed in 1997 by NSC and considerably extended in 2002. Since 2003, NAROM has operated and further developed the website under contract with NSC. It is mainly directed at students and teachers in upper primary and secondary schools, and offers resources for project tasks on weather and climate, ice in the Arctic, studies of ocean currents, Sun-Earth interaction, satellite navigation and satellite communication, as well as information on rockets, the International Space Station and space shuttles.

## Finally an autonomous Norwegian satellite?

Starting in the early 1960s and continuing to the present, the building and launching of a national satellite, without or with minimum international support, has been a recurring theme in Norway. As the history of Norwegian space activities has clearly shown – in the quest for economically and politically sound and saleable solutions in space-related activities – a satellite was one of the things that was considered too costly and flamboyant, even for larger nations and research groups. Early cooperative European satellite projects were postponed due to cost reasons and technological challenges. Throughout the 1970s and the 1980s, remote sensing began some loose comments and suggestions for the possibility of a Norwegian satellite, but this was never treated seriously by political authorities.

In the 1990s, and with the new concept of smaller satellites riding piggyback on larger payloads, resulting in higher cost efficiency, an idea surfaced in the shape of three main small-scale projects serving various needs such as education and specific matters in oceanic surveillance. The projects were NISSE, NSAT-1 and NCUBE.

NISSE was an early 1990s attempt by NDRE at building a wholly Norwegian scientific satellite intended for the study of the energy exchange in the upper layers of the atmosphere. All space physics groups in Norway were involved in the project. NSC and RCN supported the preliminary work for the satellite, and launch was scheduled for 1998. The project was, however, cancelled.[227] NSAT-1 is a late 1990s project for a Norwegian small satellite (microsatellite) for surveillance purposes, also outlined and presented by NDRE, and currently still in planning. NCUBE is a small-scale satellite project (nanosatellite) established for educational purposes with the aim to enable students to work on the design and assembly of a first Norwegian 'student' satellite.[228] This project was created by student groups at the Norwegian Technical University and the Narvik Regional College in 2001.[229] The satellite is scheduled for launch in the autumn of 2004.

The small-scale satellite projects may be examples of future space activities.[230] The new satellite projects are small, in every way, and very cost efficient. Additionally, NCUBE has represents the determination for the expansion of educational resources. All three projects can be seen to complete the circle back to the 1960s and the initiatives to build satellites.

[227] NISSE: *Norwegian Ionospheric Small-Scale Experiment.*
[228] http://www.forskning.no/Artikler/2004/februar/1076421082.27
[229] In 2001, the project was set up and small pre-study projects performed. A group at the Norwegian Technical University wrote about a possible student satellite, while a group at Narvik university College looked at possibilities to launch such a satellite – both from Norway and other possibilities.
[230] Aviation Week & Space Technology, December 2003, 'Smallsats grow up'

## Conclusions and Remarks

ESA membership coincided with the establishment of the Norwegian Space Centre as the national body for the coordination of a national space effort. To what extent have the visions and strategies drawn up by NSC come true? The answer must be a nuanced one.

There has been an important increase in space-related economic activities, which was one of the overall goals from the outset. However, two-thirds of the space-related services and products delivered by Norwegian companies have been in satellite communication, and only two large-scale companies – Telenor, the former telecommunication monopoly, and the manufacturing firm, NERA – are active in this field. The same two firms were present in the field well before 1987, and their present-day activities are largely the result of strategies drawn up in the early 1970s as previously discussed. In the late 1990s, Telenor expanded its space-related business substantially by purchasing stakes in the satellite segment. Although some Norwegian manufacturing firms have delivered equipment for the space and ground segments of launchers and satellites, as yet no Norwegian firm has emerged as a major producer of space technology. However, two important industrial groups, Kongsberg and Raufoss, have both singled out deliveries for ESA launchers and satellites as central to their development strategies and have put up subsidiary companies to be active in the field. A handful of smaller Norwegian firms keep a presence by bidding for ESA contracts. The only Norwegian manufacturing firm solely dedicated to space technology – AME Space – still remains a very small company. Despite a solid footing in its niche, the firm was recently rescued at the last moment from being closed down by its former owner, the French Alcatel conglomerate, due to its poor economic performance.

Earth remote sensing was selected by NSC as a field in which new services could be turned into profitable business ventures, serving both public and private markets and benefiting from opportunities offered by ESA membership. The requirement by Norway for remote observation as a tool for sea surveillance was crucial for the decision to join ESA in the 1980s, as was the hope of making satellite-based remote observation a vehicle for national technology and business development. One Norwegian industrial firm has taken up the challenge. Kongsberg Gruppen is active in the delivery of ground stations and satellite data. It is noteworthy that in its efforts to promote Earth remote sensing as a national technological and commercial strategy, NSC has had to break from its traditional role as a government agency. It joined the Kongsberg Gruppen as a joint venture partner in Kongsberg Satellite Service which is responsible for operating two Norwegian satellite stations in Tromsø and in Svalbard. The joint state/private ownership may indicate that the market is not yet ripe for a fully commercial enterprise.

A field in which Norwegian space effort has seen an indisputable success is in the marketing of space research facilities. In northern Norway and in Svalbard, Norway has established two launch sites for sounding rockets and a range of large-size space research facilities, such as EISCAT and ALOMAR. In recent years, the facilities in the Svalbard archipelago have expanded into a centre for space research which has proven highly competitive in the international market for ground research services. The 'business idea' has been a traditional one in Norwegian space activity since the early 1960s and as far back as the Auroral Observatory founded in Tromsø in 1930: Norway's geographical location is ideally suited for making observations in the polar region. Even more ideal is the position of Svalbard, halfway between the Norwegian mainland and the North Pole, and blessed with the most favourable climate of all sites on the same latitude. Svalbard has been developed as a world centre for space science facilities, and for the downloading, processing, disseminating and storing of satellite data, especially those in polar orbit.

The Achilles heel of the Norwegian space effort has been space science research. In spite of an impressive performance as a partner in the SOHO programme, and extensive participation in other ESA science programmes, notably Cluster, Norwegian space-related science seems to be working under constraints deriving both from the scarcity of qualified manpower and from scant financial resources. The funding available for national space science has not been able to keep up with the Norwegian contributions to the ESA mandatory science programme. This situation has been subject to open and,

often, heated debate between NSC and the Research Council of Norway. The debate reiterates arguments about forging a coherent national programme for space science and technology that have been heard continually over the last 45 years. The problems in harmonising technological, economic, political and scientific interests in a small country like Norway in the face of 'big science and technology' constituted by space activities are basically the same in the beginning of the 21st century as they were in the middle of the 20th.

Norwegian space activities are facing both an interesting and a challenging future. Some of the significant characteristics of these activities, and the way in which they have been performed, on a small scale and with limited resources, can in some ways be seen as a pathway to the future. Conversely exists the ever-present need to accept the challenges of dealing with space-related activities as a resource-demanding endeavour. Norway has grown from being a very small nation, with modest financial resources at the beginning of the 20th century to becoming a relatively wealthy state at the beginning of the 21st. It has also become a large nation in space activities as seen in relative terms, but there are plenty of opportunities to increase the spending and efforts going into this particular sector, especially in strengthening the scientific capacities. Time will tell if Norwegian space activities will go from being mainly 'down-to-Earth' to becoming more far-reaching. A saying goes that if one wants to reach the treetops, one has to aim for the stars. Norwegian space activities in the past 40 years have gone well beyond the treetops, but rarely without considerations for the cost of the endeavour to reach for the stars.

# Appendix I: Reference Literature and Background Reading


- Collett, John Peter and Bjørn Lossius, Visjon, forskning, virkelighet. Televerkets Forskningsinstitutt 25 år, Kjeller 1993
- Collett, John Peter, Making Sense of Space – The History of Norwegian Space Activities, Universitetsforlaget, 1995
- Collins, Guy, *Europe in Space*, Macmillan, 1990
- Egeland, Alv, 4, 3, 2, 1, fire! : historien om Andøya rakettskytefelt gjennom 40 år : med nasjonal og internasjonal romforskning ved hjelp av raketter, ballonger og bakkeinstallasjoner, Andøya rakettskytefelt, 2000
- ESA Bulletin, European Space Agency (misc. vol.)
- Hultqvist, Bengt, Rymden, vetenskapen och jag : en memoarbok om svensk rymdforskning under efterkrigstiden, Stockholm, Kungl. vetenskapsakademien, 1997
- Krige, John (A. Russo and L. Sebesta), *A History of the European Space Agency 1957-1987*, Noordwijk, ESA, 2000
- Krige, John, The prehistory of ESRO 1959/60 : from the first initiatives to the formation of the COPERS, HSR 1, European Space Agency, 1992
- McDougall, Walter A., The heavens and the Earth – a political history of the space age, New York, 1985
- Nasjonal langtidsplan for romvirksomhet, published annually 1989-2002
- Norwegian space centre, Annual reports 1987-2002
- Røberg, Ole Anders, Vitenskap i krig og fred – astrofysikeren Svein Rosseland i norsk forskningspolitikk 1945-1965, Forum for universitetshistories hovedoppgaveserie, UiO 2001
- Stiernstedt, Jan, *Sweden in space : Swedish space activities 1959-1972*, Noordwijk, European Space Agency, 2001
- Trischler, H., The 'triple helix' of space – German space activities in a European perspective, HSR 28, Noordwijk, European Space Agency, 2002
- United States-European Collaboration in Space Science, Washington, D.C., National Academy Press, 1998
- Wormbs, Nina, Vam älskade Tele-X? Konflikter om satelliter i Norden 1974-1989, Gidluns förlag, 2003

# Appendix II: Acronyms

| | |
|---|---|
| ALOMAR | Arctic Lidar Observatory for Middle Atmospheric Research |
| ARR | Andøya Rocket Range |
| CEPT | European Conference of Postal and Telecommunication Administration |
| CETS | European Conference on Satellite Communication |
| CNES | Centre National d'Etudes Spatiales |
| Copers | Preparatory Commission for European Space Research (1960-1962) |
| EB | Elektrisk Bureau |
| EISCAT | European Incoherent SCATer Facility |
| ELDO | European Launcher Development Organisation |
| Envisat | Environment Satellite |
| ERS | European Remote Sensing Satellite |
| ERTS | Earth Resources Technology Satellite |
| ESA | European Space Agency |
| ESC | European Space Conference |
| ESP | Esrange Special Project |
| ESRO | European Space Research Organisation |
| GEERS | Preparatory Commission for European Collaboration in the Field of Space Research (NATO) |
| IFTA | Institute for Theoretical Astrophysics (Oslo) |
| IGY | International Geophysical Year |
| Inmarsat | International Maritime Satellite Organisation |
| Intelsat | International Telecommunication Satellite Organisation |
| ISIS | International Satellite for ionospheric studies |
| KLMSDS | Kongsberg Lockheed-Martin Space Data Services |
| KSAT | Kongsberg Satellite Services |
| KV | Kongsberg Våpenfabrikk |
| Marots | Maritime Orbital Test Satellite |
| NASA | National Aeronautics and Space Administration |
| NATO | North Atlantic Treaty Organisation |
| NAVF | The Norwegian Research Council for Science and the humanities (1949-1993) |
| NDRE | Norwegian Defence Research Establishment (FFI) |
| NFT | Norsk Forsvarsteknologi AS (Norwegian Defence Technology) |
| NIFRO | Norwegian industrial forum for space activities |
| NOT | Nordic Optical Telescope |
| NRK | Norsk Rikskringkasting |
| NRSE | Norsk Space Centre Properties |
| NSC | Norwegian Space Centre (from 1987) |
| NSTR | Nordic Sea Test Range |
| NTA | Norwegian Telecommunication Administration |
| NTNF | The Royal Norwegian Council for Scientific and Industrial Research (1946-1993) |
| NTNFR | NTNF Space Activity Division |
| NTR | Norwegian Telecom Research (later Telenor R&D) |
| OECD | Organisation for Economic Cooperation and Development |
| RCN | The Research Council of Norway |
| SOHO | Solar And Heliospheric Observatory |
| STK | Standard Telefon og Kabelfabrik AS |
| STSK | Scandinavian Telecommunication Satellite Committee |
| SvalRak | Svalbard Rocket Range |
| SvalSat | Svalbard Satellite Station |
| TSS | Tromsø Satellite Station |
| TSS | Telenor Satellite Services |
| TTS | Tromsø Telemetry Station |
| UNIS | The University Centre on Svalbard |

## Appendix III: Summary of Events

**1960**
- Establishment of a preliminary Norwegian Committee on Space Research in January, followed by a permanent committee in October.

**1961**
- Norway declines membership in ELDO.
- Esrange decided to be placed in Kiruna, Sweden, not at Andøya, as hoped for in Norway.

**1962**
- Norway abstains from ESRO membership at the intergovernmental conference in Paris in June, after participating in COPERS in the years 1961-1962.
- The first Norwegian sounding rocket launch from Andøya Rocket Range (ARR) in August.

**1964**
- ESRO established without Norway as a founding member. (Norway continued as an observer in ESRO until 1975, and then in ESA until 1981).
- The NTNF Space Research Committee is dissolved, and replaced by a Committee for Space Activities, signalling a shift in science policy-making for space efforts in Norway.
- The plans for an ESRO station at Svalbard is met with objections from the Soviet Union, its representatives claiming that such an installation could be seen as a breach of the 1920 Svalbard Treaty.

**1965**
- Agreement signed between ESRO and NTNF for the use of ARR as a preliminary launch site for sounding rockets until Esrange became operational in 1966.
- The Norwegian government signs an agreement with ESRO allowing ESRO to enter a contract with NTNF concerning the establishment and operation of a satellite station at Ny-Ålesund.
- The new NTNF Committee for Space Activities, the NTNF Space Activity Division, presents its first five-year plan, which includes a proposal for a Telemetry station in Tromsø and the construction of a Norwegian satellite for research purposes.

**1967**
- Tromsø Telemetry Station is established.
- The question of Norwegian membership in ESRO is again treated in NTNF, but never reaches the general political level.

**1968**
- The ESRO Kongsfjord Satellite Station becomes operational.

**1972**
- The Esrange Special Project (ESP) for sounding rockets and balloon activities starts at ARR and Kiruna.

**1973**
- The Norwegian government rejects a second proposal for ESA membership, but participation in Marots is found to be necessary because of the country's strong maritime interests.

**1975**
- EISCAT agreement signed by six European nations, including Norway.

**1979**
- Inmarsat convention becomes operational with Norway as the fourth largest investor.

**1981**
- Norway becomes an associated member of ESA (April).

**1983**
- Norway becomes active partner in the Tele-X project.
- Norway signs cooperative agreement with ESA on ERS-1.

**1984**
- Norway decides to participate in ESA ERS-1 remote sensing satellite. AME and Spacetec receive a major share of the industrial return.

**1985**
- Norway signs agreement concerning full membership with ESA. (December)

**1986**
- NIFRO is established.
- Official report on Norwegian space activities published. (NOU 1986:1)

**1987**
- Norway becomes full member of ESA. (January)
- The Norwegian Space Centre is established as a coordinating and strategy-making organ for Norwegian space activities. (June)

**1990**
- Tromsø Satellite Station (renamed from Tromsø Telemetry Station in 1988) is merged with the Norwegian Space Centre.
- First launch of a Japanese payload from Andøya Rocket Range. (February)

**1991**
- The NSC signs data access agreement with ESA to record ERS-1 SAR data at Tromsø Satellite Station. (July)
- The Andøya Rocket Range becomes an operational unit of NSC. (September)
- The NFT receives contracts for the Ariane 5 project.

**1993**
- Agreement concerning the establishment of an EISCAT Svalbard Radar signed. (June)

**1994**
- ALOMAR facility at Andøya officially opened. (July)

**1995**
- SOHO is launched, becoming the largest and most successful participation in a scientific project for any Norwegian research institution ever.
- Tromsø Satellite Station made into a joint stock holding company, TSS A/S. (January)
- The launch of a Canadian Black Brant XII rocket from ARR, causes diplomatic strains between Norway and Russia. (January)
- The Swedish Space Corporation and NSC become 50/50 shareholders in TSS A/S. (March)
- NTA becomes Telenor A/S.
- AME Space becomes supplier for the Globalstar mobile satellite communication system.
- NFT becomes Kongsberg-gruppen.
- Sea Launch is established with the Norwegian conglomerate Kværner as partner.

**1996**
- First phase of construction of SvalSat.
- Cluster I ends in disaster after launch, resulting in questions being raised in Norway on the use of money for large-scale space research.
- First Space Camp held at Andøya.

**1997**
- Establishment of SvalRak (Svalbard Rocket Range).
- The educational website SAREPTA is initiated.

**1998**
- NASA expands activities at Svalbard by installing the NASA Isbjørn Facility at the premises of the SvalSat.
- Kongsberg Lockheed-Martin Space Data Services is established.
- ALOMAR approved by the EU as a 'Large-Scale Facility'.

**1999**
- SvalSat (Svalbard Satellite station) officially opened. (September)
- MIDAS, a Norwegian-German rocket research project is started, and continued until 2003.
- AME Space renamed Alcatel Space Norway.

**2000**
- NAROM established.
- Breakthrough for SvalSat by being chosen by Eumetsat as main station for the METOP satellites.
- Telenor becomes partly privatised, becomes the largest single shareholder in Inmarsat.
- Cluster II is launched with Norwegian participation.

**2001**
- NRSE acquires Lockheed-Martins share in KLMSDS.

**2002**
- Establishment of Kongsberg Satellite Services (KSAT).
- ESA uses SvalSat for ERS-2 satellite.

**2003**
- Construction of a fibre optic cable for high-speed communication with mainland Norway from the SvalSat.
- Alcatel Space Norway is closed down, but later reopened under the name of AME Space.

**2004**
- The Norwegian Space Centre formally becomes a state agency, administratively positioned under the Department of Trade and Commerce. (January)
- Nera SatCom becomes the global market leader in mobile satellite communication.
- Efforts initiated to coordinate the policies of space research in Norway between NSC and the Research Council of Norway.