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CERN AND ESA: fundamentally contrasting organisations?

A look at two major institutions set up by European states for scientific and technological purposes, but quite separate from the European Community - the European Organisation for Nuclear Research (CERN) and the European Space Agency (ESA)

CERN was set up in 1953 as the vanguard for a united Europe. It was uncontroversial because it was to be concerned solely with fundamental civil scientific research in particle physics. ESA, however, came into being over 20 years later, following the less successful European Space Research Organisation (ESRO) and European Launcher Development Organisation (ELDO). It was also to be concerned solely with civil space activities. Now CERN is exclusively dedicated to fundamental research, but only the core activity of ESA concerns scientific research. A need has been identified to develop space transportation systems and satellites capable of a number of civil functions (such as telecommunications).

Hence for ESA it was clear that, while Member States should participate in the science programme on a mandatory basis determined by relative gross national products (a similar basis is used for CERN's total budget), other programmes should be funded on an optional basis. Each Member State could contribute to optional programmes a share reflecting its interest, although participation would not be expected to fall below a quarter of its GNP share. This has allowed the ESA programme to develop so that at any one time it reflects the aspirations for space activities of the majority of Member States.

Bringing Europe together

Behind the establishment of both CERN and ESA was the ideal of collaboration, enabling Europe to become a major world power in these fields. The desire with CERN was to catch up and compete with the USA in fundamental particle physics research. This objective has been achieved, so CERN now collaborates as an equal with the major laboratories in the USA and elsewhere. This in turn has led towards planning on a world scale for the very expensive facilities in the field, an avoidance of duplication and an attempt at sensible phasing. The Superconducting Super Collider (USA) is a proton on proton machine scheduled for the mid-1990s, whilst the Large Electron Positron collider

(CERN) is to start up in 1989. They are complementary and will both be used by scientists from each continent.

ESA activities are more diverse, but on the scientific side again planning has been carried out firstly to secure unified European goals as well as to collaborate extensively with NASA in the USA. However, some Member States interpret the ESA Convention as meaning that Europe should be independent of other space powers in using and exploring space; indeed some Member States wish ESA could become completely autonomous in all activities. Other Member States more realistically believe Europe should be competitive within limited areas, by having a satellite launching capability and being able to participate in major ventures such as the US Space Station.

At the core of ESA activity is the fundamental science programme serving primarily astronomers and planetary scientists, taking advantage of observing and travelling in space. Processes in the universe are diverse and investigating them provides information on its formation and constituents, leading to insight on the formation of matter and the forces operating on it.

In CERN the same objectives are achieved by carefully controlled experiments creating and studying the most fundamental particles. The underlying objectives for particle and space physics have a great deal in common; indeed, the two approaches are complementary.

It is not easy for a group of independent states to collaborate, to have the will to 'give and take' over national interests, and build a truly European venture comparable with the world leaders. Securing consensus on budgets and forward plans is difficult, and even more difficult to sustain over the possibly long period a major programme may take to come to fruition. Indeed CERN only achieved equality with the USA facilities after 15 years of dedicated effort. In the process, national facilities (for example NINA and NIMROD in the UK) were phased out. West Germany remains the exception: its excellent DESY laboratory in Hamburg complements the

CERN facilities and is viewed as a European laboratory because many scientists throughout Europe can use it in conjunction with German scientists. However, once CERN achieved pre-eminence, European physicists found it a natural and stimulating experience to work together. The momentum and motivation was such that many gained world supremacy in their researches, and two gained Nobel prizes. CERN's success and the presence of so many eminent scientists led to the decision to build LEP for the next major advance in the field; this was agreed in 1981 by all Member States, at a constant budget level over seven years.

Even though the goals for ESA have been wider, there have been similar achievements. After extensive scientific discussions, a carefully balanced major programme of scientific missions was presented to the Ministers of all ESA Member States in 1985. The scientific goals and timescales of this 'Horizon 2000' programme were accepted by all.

Funding implications for the first ten years were, however, subject to much discussion. The ESA Executive felt the programme would need an annual increase of 7% pa compound up to 1994, but eventually 5% pa was agreed up to 1989, with the matter to be reconsidered at the next Ministerial meeting in 1987. By 1989 the budget for 'Horizon 2000' would be £177 MAU pa (about £125m pa).

In difficulties?

Readers cannot help but be aware of the events of the last two years which have prevented the continued confident expansion of both CERN and ESA programmes. In both areas the UK's financial difficulties have been central to the problem, although the Shuttle disaster and temporary stop to American launches, and delays in the Ariane programme have also undermined ESA's position.

In the UK, the Science and Engineering Research Council is responsible on the government's behalf for paying (as well as advising on) the country's contributions both to CERN and ESA, for the mandatory science programme and part of the general budget. Coinciding with the shortage of funds for important national programmes within SERC's remit, the contributions to be paid to both European organisations increased dramatically, due to the pound deteriorating against the Swiss franc for CERN and other European currencies for ESA. Over the same period the UK's GNP increased relative to those of the other Member States, leading to an increase in the UK's share of the budgets. Figures 1-3 show the effects since 1980 of increased costs in exchange rates, GNP values etc for the same volume of science.

Unlike those of almost all other European Member States, the UK Treasury does not automatically compensate for changes in exchange rates or GNP. If the pound's value falls relative to the Swiss franc or the ESA Unit of Account then the SERC has had to find the money or make bids for extra funds to the Advisory Board.

for the Research Councils. From time to time the SERC has received 'ex gratia' payments, but there is as yet no systematic way to deal with the problem and this has resulted in severe disruption to the SERC planning process. Naturally the SERC has been in discussion with government departments, but to no avail so far.

Under this intense pressure the SERC could not sustain the CERN subscription and so jointly with the ABRC conducted a review of particle physics in the UK in 1985, which strongly recommended that our contribution to CERN be reduced. While believing 'that the UK has a strong moral obligation to remain a member of CERN at least until the end of 1989' the report recommends 'an immediate review of the future financial structure of CERN once the LEP collider is in operation, expecting a significant fall in the budget of the laboratory in 1989', expecting some savings could be made in staff costs earlier, with the UK 'looking for successive reduction in its subscription of, say, 5% in 1988-9 rising to a total of 25% in 1991'. Of course the UK cannot unilaterally change the CERN Convention and so ways of generating income as well as making savings were suggested. The Parliamentary Under Secretary of State at the Department of Education and Science subsequently had intensive consultations with his opposite numbers in several European states, and in 1987 CERN's Council resolved to set up a Review Committee with the task:

- to advise the Council how human and national resources, employment conditions, structure, operations and future use and development of facilities might be developed to operate with maximum cost-effectiveness and value for money at alternative levels of funding by present Member States, and to assess their consequences for the CERN programmes and for the services to Member States;
- to assess the possibilities for engaging and enlarging other sources of funds and resources.

The Review Committee was chaired by Professor Abragam and its interim report was considered by the CERN Council in June 1987, the final report being presented in December 1987. CERN Member States are now considering the latter. One feature was the UK's insistence that alternative levels of funding should be considered, ranging from constant contributions (at 1986 levels) to reductions of 25% over the next 5-7 years. A clear belief has emerged that CERN's costs can be substantially reduced and other means of securing income realised.

ESA's programme has been complicated by the need for major initiatives compatible with the objectives of the organisation - not only 'Horizon 2000' for pure science but also (optional) programmes for research in the weightless environment of space (microgravity), earth observation and telecommunications. These have to be underpinned by infrastructure programmes for transportation (launchers and the space station) and by

Figure 1 The actual cost of the SERC of CERN and ESA in £m (to ESA figures must be added a 5% pa increase for Horizon 2000, paid by other government departments, from 1983-4 onwards)

Figure 2 The effect of exchange rate fluctuations and relative GNP changes on UK payments for CERN science. The basic contributions are adjusted every 3 years

Figure 3 CERN and ESA subscriptions as a percentage of total particle physics and astronomy spending, respectively

technology research and development. All are currently linked with developing NASA programmes.

The microgravity programme is reliant on the ESA part of the US Space Station (Columbus), whilst earth observation is related to eventual involvement in Columbus' Polar platform. Transportation is especially centred on development of the Ariane rocket launcher V, which could carry a smaller shuttle-like vehicle (Hermes) to service the European parts of the Space Station. Hotol and other launchers to leave earth in the style of aeroplanes (as opposed to rockets which are more costly) remain prospects for the next century. Undoubtedly the main stumbling block to effective use of the space environment and exploration is a cheap way of getting there. Whilst the USA has been planning the Space Station with ESA and other countries, the USSR has launched its own smaller space station, MIR, and been using this for two years. Astronauts and experiments have been regularly ferried up and down from MIR by the Proton launcher. With the advent of 'Glasnost' and the coincident Shuttle immobilisation, the USSR has made overtures to West European countries to collaborate with experiments on its scientific satellite programme or on MIR. Hence a major collaboration with a West European lead is being seriously considered for launch in 1992 - this is an x-ray astronomy mission, Spectrum-X, involving scientific groups from the UK, Germany, France, Denmark and The Netherlands, as well as East European and USSR groups.

A major setback...

The Shuttle accident in January 1986 has greatly affected the Western world's pro-

gramme. NASA operates internationally and proposals for its scientific mission experiments may come from any country. Needless to say European and American scientists frequently collaborate on complementary instruments for the same satellite. Several fully instrumented satellites were ready or at an advanced stage when the accident occurred. Most notable was the Hubble Space Telescope, originally due for launch in 1987 and thereafter to observe indefinitely, being serviced at intervals by the Shuttle. It is now scheduled to fly in June 1989.

The space telescope 'will present a leap in orders of magnitude on observational capability in optical astronomy', and will operate as a 'Great Observatory' so all scientists worldwide may apply for observing time on it. The range of proposals will probably be enormous, but the telescope should firstly be able to determine whether or not there are planets around other stars. This clearly represents a first step towards answering 'is there life elsewhere in the universe?'. Secondly, the value of the Hubble constant should be obtained (hence the telescope's name), which relates to the scale and age of the universe.

Until now, satellite observations have mainly concentrated on those wavelengths absorbed by the earth's atmosphere, which therefore cannot be studied from the earth's surface. Some satellites have had life expectancies of only months or years; whereas some have failed earlier than expected, others like the IUE (International Ultraviolet Explorer) have continued well beyond their planned lifetime. GIOTTO, which successfully encountered Halley's comet in 1986, is still continuing its flight and may be reactivated to rendezvous with comet Grigg-Skjellerup in 1992.

In Europe, 'Horizon 2000' is both com-

plementary to and competitive with the American science programme. It has four major missions spaced at about five-year intervals, called the four 'cornerstones'. This programme has been carefully balanced to ensure continuing scientific exploration for the many space science groups in European universities and institutes. Proposals for the first mission, Solar Terrestrial Physics (SOHO/CLUSTER) which will study the relationship between the earth and the sun, are now being considered: more than 500 scientists from all over the world are involved. The mission is collaborative with NASA, and the USSR is also expected to play a part. SOHO will observe the sun, its corona and the solar wind; CLUSTER is a four-spacecraft plasma physics mission for observing reactions of the magnetospheric space plasma to the varying solar conditions. Both will be launched in 1995.

The next cornerstone will be an x-ray spectroscopy mission followed by two others (the order has not been decided): one to study far infrared phenomena, and the other to encounter and bring back a sample of the nucleus from a comet.

Unfortunately, the UK's extreme financial difficulties are also influencing this programme. ESA, despite warnings from the UK delegates to the ESA Science Programme Committee, continued to plan on the basis of a 5% pa compound increase to 1994 or thereabouts - arguing this was necessary for an appropriate timescale. However, the UK has warned since 1985 that this could not be afforded, and the situation came to a head at the ESA Ministerial meeting in November 1987. The Chairman of the SERC (a UK representative) said the increase to 1989 was adequate to pursue the main scientific objectives of the programme: 'after the 27%, i.e. 5% pa compound over five years, increase we wish to see the scientific programme contained within that budget level. This can be done in our opinion without the loss of scientific integrity - an extension of the period is neither going to destroy the programme nor make the intervals between missions too long'.

Subsequently the government charged the new Advisory Committee on Science and Technology (ACOST) to advise it on the value of the science programme in the context of UK R and D programmes. The findings are not yet complete but in the meantime the House of Lords Select Committee on Science and Technology published a report in January critical of the lack of a clear UK policy for space, concluding and recommending *inter alia*:

'The government's silence over the British National Space Centre's space plan was misleading and contributed to the atmosphere of damaging uncertainty during 1987.'

'The United Kingdom needs a clear policy for space which is adhered to firmly and consistently. The government should formulate a positive space policy and make a full statement of that policy. This should be supported by a national space plan which should be published and updated regularly.'

'The case for space is not only one of science and technology. It is political, cultural, economic and military as well. The Committee recommend that the United Kingdom play a visible and effective part in the exploration and exploitation of space.'

The government is expected to respond to this report before the summer recess.

The UK position

A similar line was adopted on the other major new initiatives and Kenneth Clarke, Minister for Trade and Industry, has recently reaffirmed to Parliament the UK position: 'I remain wholly committed to a programme of scientific research in space and in particular to the European Space Agency's 'Horizon 2000' programme. This has received a 20% real terms increase in funding over the last three years and I am satisfied that the present level of planned funding will enable the objectives of Horizon 2000 to be met satisfactorily'. There is a parallel with CERN, in that the ESA science budget will be reduced by some 20% pa of that planned.

The UK was the only Member State to take this line regarding Horizon 2000, all the others having agreed the 5% pa increase to 1994, so it is now seen as blocking the ambitions of the other 12 states. What happens next? The UK has asked ESA's Executive to prepare a programme within the 1989 'Level of Resources' continued for five or more years, but so far the Executive has been more concerned to show the extent of the damage. For example, the second cornerstone XMM (x-ray mission) scheduled for 1998 would now move to 2002-3. Would x-ray groups in universities be able to continue with a 12-year gap? The third and fourth cornerstones would be cancelled and the medium-sized missions, already reduced in number by a quarter, would either be further reduced or delayed. Yet in my opinion a budget of £125m pa must be able, over ten years, to achieve significant space science. The question is the extent of the modification to Horizon 2000.

Apart from reconsidering ESA's science programme, should there be a similar review to that of CERN? In view of the Abragam report the idea has considerable attractions, but it is not quite so simple because of the differences in the mode of operation and the Conventions.

The key difference is the extent to which ESA and CERN employ staff. CERN in 1988 employs around 3500 people at one major laboratory and its budget is about SwFr783m pa (i.e. ~£326m). ESA has about 1500 staff distributed over several sites, none of its laboratories being very large. ESA's budget for science in 1986 was 154 MAU (~£107m); its total budget for all programmes (earth observation, microgravity, telecommunications, space station, space transportation and general) was around 1450 MAU (~£1015m). About 90% goes on placing contract work to industry or other research institutes. Most of the funds are returned to Member States' industries on a 'juste retour' basis. Indeed

this was intended when ESA was set up and there are crucial differences in the CERN and ESA Conventions.

Both 'provide for ... collaboration among European states' exclusively for peaceful purposes. CERN is solely concerned with 'research of a pure scientific and fundamental character, and in research essentially related thereto'. Its wider activities can only be concerned with the 'organisation and sponsoring of international cooperation', including 'collaborating with and advising other research institutions'. Not so ESA, which has the purpose of providing for and promoting 'cooperation among European states in space research and technology and their space applications'. The Convention firmly elaborates on this: ESA should coordinate the European space and national programmes 'progressively and as completely as possible with the European space programme, in particular as regards the development of applications satellites'. It further has the remit 'of elaborating and implementing the industrial policy appropriate to its programme and recommending a coherent industrial policy to the Member States'.

Control of CERN's costs has always been within the capability of the CERN Council, but the Abragam review clearly indicates that neither the Council nor its Finance Committee really achieved this. Can the Member States control the costs of the ESA programme, given its very wide remit? A CERN-type review is not on, but how can strict financial control be exercised on international organisations concerned with fundamental research requiring very advanced technology?

Remaining questions

The achievements and future programmes of both CERN and ESA demonstrate there is a strong 'will' within Europe to collaborate on major scientific ventures. Is the UK at the heart of this? Is the UK prepared to find the extra resources to continue as a full member of these two organisations?

To what extent has the desire to increase 'strategic' or exploitable research within a more or less constant budget, coupled with the exchange rate problem, influenced the UK's attitude and sapped its ability to participate whole-heartedly and generously, whilst sustaining those UK scientists playing a leading role in their endeavours? ▴

Further reading

- High Energy Particle Physics in the United Kingdom* ABRC and SERC (June 1985)
- CERN Review Committee: interim report* (June 1987)
- Final Report of the CERN Review Committee* (December 1987)
- Hansard report*, 10 February 1988
- CERN Annual Report 1986* (June 1987)
- ESA Annual Report 1986* (March 1987)
- 'Convention for the establishment of a European organisation for nuclear research' Paris, 1 July 1953

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