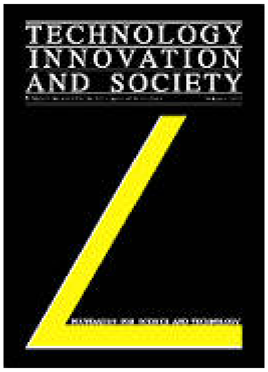
THE FOUNDATION FOR SCIENCE AND TECHNOLOGY



EUROPEAN SPACE POLICY

The Foundation held a lecture and dinner discussion on the subject “Can a European Space Policy be SelfSufficient, and is One Necessary?” at the Royal Society on 25 January 2000. The Rt Hon The Lord Jenkin of Roding was in the chair and the evening was sponsored by BNSC, DERA, Logica UK Ltd, Matra Marconi Space and Science Systems plc. The speakers were Mme Claudie AndreDeshays, European Space Agency Astronaut, Dr Alain Bensoussan, President of CNES, Chairman of ESA Council, and Dr Colin Hicks, Director General, British National Space Centre.

Mme Claudie AndreDeshays

European Space Agency Astronaut

Summary: Mme AndreDeshays discussed the setting up of the International Space Station. She argued that her own experience with biological experiments on her Mir mission emphasised that manned flight could prove more effective than the limitation imposed by dependence on robotics. Dr Hicks outlined the strategy of the UK in relation to the European Space Agency.

EUROPEAN CONTRIBUTION TO THE ISS (International Space Station) PROGRAMME

Introduction: European Space Agency microgravity programme overview

Research under microgravity conditions has been undertaken in Europe for the past 15 years, both through ESA’s microgravity programmes and initiatives at national level. The past and present research programmes highlight how microgravity can be a useful and unique tool for the study of physical, chemical and biological processes that are important in science, engineering and technology.

The European Space Agency supports European research under microgravity conditions through the following activities:

- ESA develops multiuser experiment facilities needed to perform microgravity research in space by the various user communities (life sciences, physical sciences, material sciences, etc.)
- ESA develops the spacecraft on which these facilities can fly (e.g. Spacelab, Columbus) or provides flight opportunities for these facilities on spacecraft of other space agencies or industrial contractors (e.g. Foton, sounding rockets, Spacelab, US Laboratory of the International Space Station)

Presently, there are two ongoing ESA microgravity programmes. They were approved by the ESA member states in 1995:

EMIR2: The European Microgravity Research Programme No. 2. EMIR2 is essentially a microgravity research programme not only devoted to ISS. ESA also makes use of European sounding rockets, Russian retrievable capsule and the US Space Shuttle. Space itself is not a prerequisite for microgravity experiment, since parabolic flights or drop towers and tubes provide at least several seconds of weightlessness. The use of this wide kind of carriers has provided the foundation for a strong intensification of microgravity research and applications activities in Europe. After more than 15 years, the high integration of space research and groundbased research indicate that space flight is seen as a real research tool for addressing not only questions related to microgravity but also fundamental questions of general interest with the constant preoccupation to emphasise transfer between earth and space.

MFC: The Microgravity Facilities for Columbus Programme covers the development of the large multiuser facilities to be accommodated in the European Columbus laboratory on the International Space Station.

In addition, microgravity research is supported by ESA through the development of multiuser facilities and the provision of flight opportunities for the early utilisation phase of the International Space Station. These support activities are financed from a special budget line, called “Utilisation Preparation”, which is part of the ESA development programme for the European participation in the International Space Station. The “Utilisation Preparation” budget includes a programme element called “Microgravity Application Promotion” (MAP). It also includes the development of the European Drawer Rack and the Stowage Rack for the European Columbus laboratory.

The Microgravity Application Promotion programme’s objective is to develop pilot projects demonstrating the large potential of the International Space Station for applicationoriented research under microgravity conditions, with a particular emphasis on industrial research. A major aspect of the MAP programme is the setting up of Europewide teams and networks involving partners from academia and industry. These teams are called “Topical Teams”. They will work jointly on industriallyrelevant research. The aim is to initiate concrete industrial projects in which research performed in laboratories on Earth is supported and complemented by research in space.

Mme Claudie Andre-Deshays, European Space Agency astronaut, who spoke at the meeting, with M Michel Bernier, French Science Counsellor.

The International Space Station

The International Space Station is a global cooperative programme between the United States, Russia, Canada, Japan and Europe, for the joint development, operation and utilisation of a permanently inhabited space station in low Earth orbit.

The International Space Station will comprise several pressurised modules, in which an international crew of up to seven astronauts can live and work. External platforms will make it possible to install observation and measurement instruments on the Station and to test out new technologies in the real space environment. Fully assembled after 5 years, the ISS will total about 420 t in orbit and offer 1300m 3 of habitable volume. There will be six laboratories, all maintained with Earthlike atmosphere.

The International Space Station will be:

- A versatile research institute and a large observation platform in space for scientific research and applications in physics, chemistry, biology, medicine, human physiology, space sciences and Earth sciences;
- An innovative test centre to facilitate and speed up the introduction of new technology, equipment and procedures and space transportation systems;
- The first fully international, permanently occupied outpost of mankind in space and a stepping stone for any further human space exploration and exploration beyond low Earth orbit. The International Space Station will provide opportunities and advantages that have never been matched in quality and quantity by any space system up to now:
- Availability over a long period;
- Permanent presence of a crew;
- Regularity of access and return;
- Large resources in accommodation;
- Data processing and communications;
- Worldwide user community.

The assembly of the Station in orbit began in late 1998 with the launch of the Functional Cargo Block (FGB) “Zarya” on a Russian

Proton launcher in November. The second element, the US Node I Unity, was launched and mated with Zarya in December. Due to technical and financial problems, the ISS Assembly Sequence was revised during last year. While building is going on, from mid 2000, after the launch of the Russian module service Zvesda, a crew of three astronauts will permanently inhabit the Station. Scientific utilisation will start half a year later. Full routine use will start in 2004, and will go on for at last ten years.

Dr Alain Bensoussan, President of CNES and Chairman of ESA Council (left) meets the Chairman, The Rt Hon The Lord Jenkin of Roding (right) and Mr David Hall, the Foundation's first Director.

European Participation in the International Space Station

After the decision taken in 1995 by the European Ministerial Council of Toulouse to participate in the International Space Station, the principal documents governing Europe's participation (IGA and MOU) were signed by all international participants on 29 January 1998 in Washington. The main reasons for European Participation in the ISS programme are:

Utilisation Benefits

- Scientific research in a physical environment not possible on Earth
- Technological innovation and development of new applications
- Observation and study of the Earth and the Universe from a vantage position outside the Earth's atmosphere

Buildup knowhow

Development of the key elements required for the operation of a space station, without the need for Europe to develop the complete required space and ground infrastructure by ita own means

Political Benefits

- Fostering of international cooperation, including in particular the integration of Russia into cooperative structures
- Preparation of Europe's place in global cooperation structures

of the future

	Development Programme 2651 MECU	MFC 207 MECU
D	41	40
F	27.6	22.8
I	18.9	15.8
B	3	10
CH	2.5	4
E	2	2
DK	1.17	1.93
NL	0.94	1.5
N	0.48	
S	0.4	
TOTAL	97.97	98.03

Ten of the fourteen ESA Member States are contributing to the two programmes of which the European contribution consists.

Europe is participating in the International Space Station in various ways:

1. By developing and operating flight elements which constitute a direct contribution of Europe, as one of the International Partners in the International Space Station Programme. The five International Partners are USA, Russia, Europe, Japan and Canada. These elements of direct contribution are:

(a) The European laboratory on the International Space Station, called Columbus, planned to be launched in February 2004. The Columbus Laboratory is a pressurised, habitable module, which will be attached to Node 2 of the Station.

The Columbus Laboratory's structure is derived from the Italian MiniPressurised Logistics Module (MPLM). It is designed as a general purpose laboratory, which can support any foreseen user discipline, including materials and fluid sciences, life sciences and technology development. The Columbus Laboratory foresees the addition of external payloadcarrying structure for technology experiments, Earth observation and space sciences.

The Columbus Laboratory constitutes the European real estate property on the Station. It is the entry ticket for Europe into the International Space Station programme as a full partner and is the main workplace for the scientific and technological activities of the European astronauts on the Station. With it, Europe acquires experience of long duration, continuous exploitation of an inorbit infrastructure, with regard to both operations and utilisation.

(b) an unmanned, automatic spacecraft, launched on Ariane 5, for the transport of cargo and other logistical services for the International Space Station, called the Automated Transfer Vehicle (ATV).

(c) A European contribution to the CRV program (Crew Return Vehicle) beyond the X38 partnership.

2. By developing equipment and hardware elements that will become part of the contribution of one of the other four International Partners to the Station programme In exchange, Europe will obtain hardware,

knowhow or services from the partners that will be used for Europe's own contribution to the Station.

The legal arrangements on the exchange of hardware and services are made through bilateral cooperation agreements or socalled barter agreements between ESA and the respective partner agency.

These various barter agreements have several advantages: closer cooperation with the partners, avoidance of unnecessary duplication, expansion of utilisation possibilities, and additional development and manufacture contracts in highly interesting technological areas with European Industry.

With the barter agreements, European users will have some early payload utilisation opportunities before the launch of the Columbus Laboratory once the US Laboratory module is on orbit and operational for users, as well as on the first Express pallets for external payloads in 2002.

3. By developing the onboard multiuser facilities which will accommodate the European scientific and technological payloads on the International Space Station, called the Microgravity Facilities for Columbus (MFC), as well as the European payloads that will be accommodated on trusslocated Express Pallets for launch in 2002:

The Microgravity Facilities for Columbus (MFC) Programme is the most important European contribution to the International Space Station's microgravity utilisation initiative. The MFC programme covers the development of five multiuser laboratories in the fields of Biology, Human Physiology, Materials and Fluid Science.

Four of these laboratories will be located in ESA's Columbus laboratory while one, in cooperation with NASA, is foreseen to be located in the US laboratory called Destiny.

For the MFC facilities located in the European Columbus laboratory:

Biolab is a multiuser facility designed to support biological experiments on microorganisms, animal cells, tissue cultures, small plants and small invertebrates

European Physiology Modules constitute a multiuser facility supporting physiological experiments in respiratory/cardiovascular conditions, hormonal/body fluid shift, bone demineralisation and neuroscience. EPM incorporates physiological instruments provided by the ESA microgravity programme and the national programs of ESA Members States

Fluid Science Laboratory is a rack for studying the complex behaviour in instabilities and flows in multiphase systems, their kinetics as a function of gravitational variation and the coupling between heat and mass transfer in fluids, along with research into combustion phenomena that should lead to improvements in energy production, propulsion efficiency and environmental issues.

For the MFC facilities located in the US Destiny laboratory:
Material Science Laboratory which offers a multiuser capability to support scientific research in solidification physics, crystal growth with semiconductors, measurement of thermophysical properties and the physics of liquid states.

It is the goal of the MFC programme to maintain the four disciplines constantly present and generating scientific data throughout the lifetime of the station. This will provide European and international scientists with a wide envelope of research opportunities offered from the unique vantage point of a world class facility in space.

The first phase of the MFC programme covers the initial period between 1997 and 2003. It involves the design and development of the facilities listed above. During this phase, experiment specific hardware (e.g. experiment containers for fluid science and biology, cartridges for material science) will be developed to support the multiuser facilities. This phase will also see the development of secondgeneration modules and facilities (different furnaces, a bioreactor, new physiology equipment, upgraded diagnostics) designed to enhance the capabilities of the current laboratories and provide research opportunities for the widest possible range of European researchers.

4. By preparing the European scientific and industrial user community for the Utilisation of the International Space Station.

Several announcements of opportunity (AO) have already been issued, inviting scientists, engineers and the application oriented user community to submit experiment proposals. All experiment proposals submitted in response to the AO are not only analysed by specialists from ESA and industry to investigate their technical feasibility with operational procedures and compliance with safety rules, but also assessed for their scientific relevance and the soundness of the proposed experimental approach by Peer Reviews. The Peers are selected according to their scientific renown and expertise in the proposed research disciplines. The Peer Review ensures that the ISS will become and remain a research institute for world class science.

ESA is presently formulating an overall strategy for extending the access to the Station to commercial users. The issues touch not only financial aspects, but also questions of legal responsibility, selection criteria and the protection of the intellectual property and confidential business data.

In order to make potential users aware of the Station’s utilisation possibilities, ESA has built the ISS Erasmus User Centre at Noordwijk. The ESA programme for the European Participation in the ISS includes a strong utilisation promotion element. The strategy is to bring researchers from academia with experience in microgravity experimentation into contact with researchers of industrial research and development laboratories. The contact is established by setting up “Topical Teams” addressing topics with high application potential.

5. By training and maintaining in operational readiness a corps of European Astronauts for the International Space Station. The constitution of a single European Astronaut Corps, merging the national astronaut corps, will be soon achieved with 17 astronauts.

Conclusion

As a conclusion, in my personal point of view, I think that working at this level of contribution in the ISS programme is the least Europe can do to be recognised as a full partner in the future programmes of Space Exploration and in implementation of the manned space flights to the Moon or to the planet Mars.

I think that the younger generation in Europe will be proud that we prepared the Way to the Future. The desire to participate in this venture is enormous and, right now, we can integrate this objective in their lifetime. We have in our hands a precious pedagogical material to give them the impetus for motivating projects, the appetite for science and technology.

M Michel Bernier, French Science Counsellor, talks to Dr Colin Hicks, Director General, British National Space Centre.

Dr Colin Hicks

Director General, British National Space Centre

Introduction

For those of you who are not familiar with the British National Space Centre, we are a partnership of ten organisations coordinating the civil spaced interests of the UK. This partnership consists of the Department of Trade and Industry, who contribute £90m, roughly half of the UK space budget. It includes other government Departments such as the Office of Science and Technology, the Foreign Office, the Department of Transport, Environment and the Regions and the Ministry of Defence.It also includes the Research Councils: PPARC and NERC and other agencies with an interest in space such as RAL, DERA and the Met office.

The question being put to us this evening is “Can a European Space Policy be selfsufficient and is one necessary? I want to look at this issue by looking at three questions:

- Why is it necessary?
- What will be included?
- What will it cover?

The need

Firstly, why is it necessary? The space industry today faces new challenges. Space utilisation and research is becoming increasingly commercial; it is no longer the sole prerogative of governments. Space applications are being used in new and innovative ways in new areas. This presents new opportunities as well as challenges. The European Union and ESA as well as other actors have overlapping interests which are best served through working together.

Who will be involved?

I have already mentioned the EU and ESA. Who else will be involved? Of course, at the centre of the picture will be ministers: expenditure on space is at the end of the day a political decision. Another European institution with space interests is the Western European Union. Most importantly, the Strategy needs to draw in the users such as EUMETSAT, telecommunications companies and broadcasters. Industry and the Research Community will also need to have ownership of the Strategy.

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So that’s the why and the who. But what will this European Space Strategy look like?

I suggest a European Space Strategy needs to have three levels. First of all, it needs an overarching vision that all players can share. Then it needs to set out some core objectives and finally the means of achieving them.

The vision will need to be set out by those involved, but I hope that it will mention exciting scientific and commercial prospects. I also hope it will foster strong coordination and cooperation and set out Europe’s place in the international space sector.

Dr Mike Love of Science Systems plc, one of the sponsors, talks to a guest during the evening.

Objectives

Of course, it's not for me on my own to decide what the core objectives should be in a European Strategy. That will be discussed in the coming months. However, I would like to share with you the UK's experience of devising a space strategy.

- The UK has five core objectives. These are to:
- Maximise profitable opportunities
- Exploit innovative technology
- Achieve highest quality science
- Understand the environment
- Communicate the results

As to the means, in the UK we aim to achieve these core objectives through:

- A costeffective approach
- Coordinated policies and activities
- Europe
- Public Private Partnerships (PPP)

So to return to the first part of the question: Can Europe be selfsufficient in space and should it be? This is not an all or nothing question. There are some areas such as infrastructure where it makes good sense to cooperate with other space faring nations. On the other hand, in commercial areas the best results are often achieved by fostering competition. The criteria for determining whether to cooperate or compete should be cost effectiveness.

Conclusion

In summary, I have asked why a European space strategy is necessary. We are entering a new era of space utilisation and a growing commercial environment is exerting its influence over more and more areas. To meet these challenges and opportunities, European partners need to work together. Who will be involved? The Strategy has to involve the full range of space actors. And what will the Strategy cover? This will emerge in the future, but I've shared with you this evening a little of what the UK Strategy covers.

Discussion

One contributor to the discussion asked why – other than for reasons of Community politics – there should be a Europebased space effort. Development in this field seemed to be more pushed by technology than pulled by user demand. In the UK there was evidence of userpull, for instance in relation to weather forecasting and environmental observation. Across Europe, by contrast, technologypush predominated, and the pullfactors seemed to be global rather than European.

In response, one speaker agreed that the strategic direction should be global. Different countries had different interests, but these could add up to a worldwide pattern. In the short term, however, each country had to find willing partners. The UK might want to offer systems to the US, but if that did not work the alternative might be a European partnership. It was also observed that access to European launchers and other facilities was needed if European astronomy were to be competitive. There were collaborations with the US and Japan, but the European Space Agency offered the best standard.

One speaker observed that the Agency had committed itself to producing a strategy by the end of the year, when three decades of European collaboration had failed to produce a coherent policy. One comment was that decisions had been easier in the past because the focus was on programmes with straightforward objectives. Thus the development of the Ariane launcher started from the simple idea of obtaining access to space, which was not available at the time. Now, by contrast, the object was to pursue programmes with foreseeable applications, and it was very hard to forecast the purposes which a particular line of research or development might serve. In the early days of the Global Positioning System and the Internet, for example, noone predicted their even tual impact or the range of purposes for which they would be used.

It was suggested that science and technology in the US benefited from an approach to public funding which did not concern itself with forecasting benefits. When a public need, for example in national defence, was identified a solution would be paid for by the taxpayer in the confident expectation that it would serve to create wealth. Thus the American Government made Earth observation technology available free, unlike European governments which looked for a return on their investment. In the US the intellectual property created by publicly-funded research was made available for all to exploit, and the American economy thrived on the readiness of entrepreneurs to identify profitable niches. In the UK, by contrast, companies carrying out research with public money would generally retain title to the intellectual property.

A speaker wondered whether private finance was being used in the funding of public projects in the European space programme, with risk being genuinely transferred to the private sector. Public/private partnerships entailed more than token commercial sponsorship.

There had, however, been some success in weaning researchers from a traditional dependency on public funds and getting them to pursue mixed funding, with benefits in the form of better collaboration between producers and users.

There was also much to be gained from technology transfer. The oil and gas industry had brought about a revolution in ways of working underwater, in particular using robotics, and some of the techniques might be applicable in space. Space technology still dealt in small numbers and could benefit from the results of mass production in other fields. Conversely, the methods of deep space exploration were being applied to the development of an automated submarine which it was hoped would enable oceanographers to do their job without getting seasick. The Department of Trade and Industry and the Natural Environment Research Council had both tried to encourage the lateral transfer of technology, for example bringing together scientists who made particular kinds of observation regardless of the fields in which they made them.

Jeff Gill