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West Europe Report

SCIENCE AND TECHNOLOGY

(FOUO 4/82)

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INDUSTRIAL TECHNOLOGY

AUTOMATED SPACE FACTORY PLANNED FOR ARIANE LAUNCHES

Paris SCIENCE & VIE in French Dec 81 pp 47-50

[Article by Pierre Kohler: "SOLARIS, the Space Robot"]

[Text] At the very moment when development of the Ariane rocket, of which the fourth and last qualification firing is to take place about 12 December, SOLARIS may be the next great European space achievement: an ambitious and original project and, what is more, one that has great scientific, industrial, and strategic interest.

Soon, Soviets and Americans are going to occupy space permanently: the former during the next year, thanks to a continuously operating orbiting complex *; the latter starting in 1986, thanks to a modular station assembled by the space shuttle. In this competitive situation, the SOLARIS project may be a way for Europe to confirm its space vocation and asserts its presence upon the sixth continent: the cosmos.

At present, SOLARIS (acronym for "Station Orbitale et Laboratoire Automatique de Rendez-vous et d'Interventions Spatiales" [orbiting station and automated laboratory for rendezvous and space operations]) is only a project of the engineers at the National Center for Space Studies (CNES). But it is a project sufficiently advanced to have been presented to the 32nd International Astronautics Congress, which was held in Rome last 6 to 12 September. This project, even though conceived in France, can only be carried out at the European level, since its magnitude requires financial resources which exceed our capabilities (the preliminary estimate is close to 10 billion francs). In return, because of the originality of the chosen operating sphere and the diversity of the facilities exploited, it can be the opportunity for the Europeans to manifest their own scientific individuality by entering technological domains from which they are still absent: space rendezvous, transfer operation in orbit, remotely controlled manipulation, atmospheric reentries, capsule recoveries, and so forth.

A kind of small orbiting factory whose operation is completely automated, SOLARIS, if it sees the light of day, will be a perfect example of space robotics. At present, the scope of its mission remains to be defined, but the prospects, and developments, are many.

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* See SCIENCE & VIE, No 768, p 94.

In the first place, SOLARIS will make it possible to perfect the techniques of construction and operation of a space station without human presence. Although the incorporated automation makes the complex equipment intended for the protection of astronauts and for their activities unnecessary, it does, on the other hand, require greater precision and complete reliability of its equipment.

Moreover, SOLARIS will provide new markets for the Ariane rocket in the form of supply missions. CNES, which is seeking to exploit its launcher in parallel utilizations, will find there a large market capable of extending over 15 years. As the space station launches its capsules, Ariane will deliver new ones to it, and these will be put in place by remote manipulation and will serve in experiments of different types: industrial, biological, astronautical, and so forth.

The industrial domain will have the top priority. Special alloys, difficult to obtain upon Earth because of gravity, can be fabricated abroad SOLARIS, For example, the combination of aluminum and tungsten cannot be realized down here because of the extremely great difference in the densities of the two metals; but under weightless conditions, the two mix perfectly and yield a homogeneous alloy which combines the mechanical properties of tungsten with the thermal properties of aluminum.

Another example: crystals. Under weightless conditions, they grow more easily and can attain sizes unknown on the surface of the globe. In addition, they are of greater purity. Now the fabrication of certain crystals, or of crystals of certain quality, is vital to the development of the electronics industry. Thus: mercuric iodide, used in gamma-ray detectors, does not have a regular crystalline lattice when it grows in a gravity field; in space, that problem is resolved.

Observation of the Earth will also be one of the tasks assigned to SOLARIS. But, unlike specialized satellites of the SPOT class, the orbiting station is not limited to optical observation; as a matter of fact, the plan is to equip it with a high-performance radar which could be used for civil purposes (relief cartography, wave height) as well as for military ends (detection of aircraft, ships, or various installations).

Lastly, astronomical observation platforms, laboratories for biological experiments, or experimental telecommunications relays could, either in succession or simultaneously, be "grafted" to the orbiting station.

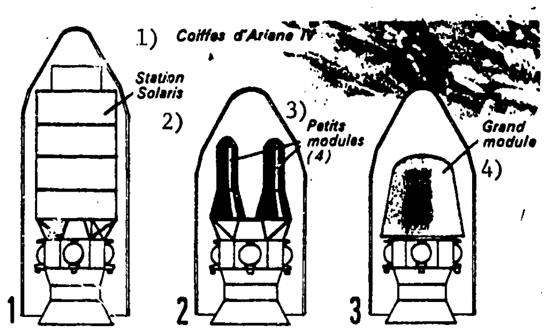
Even though it is still only in the project stage, the general characteristics of SOLARIS right now are well defined. Thus, it is known that the station will weigh between 4.6 and 5.4 tons, depending on the orbit chosen: elliptical, between 200 and 800 kilometers, or circular at 800 kilometers. In any case, this orbit will be heliosynchronous; that is, the station will always be illuminated in the same manner and will pass over a given point on Earth at the same local time every day. SOLARIS, by the way, will be equipped with two panels of solar cells, 230 square meters in area, which will provide 10 kilowatts of power. Transmission of scientific data will be accomplished by radio with a rate that can attain 400 megabauds--that is, 400 million bits (information elements) per second.

The first launch could take place toward the middle of the year 1990, aided by an Ariane IV rocket. As we have said, the service life of SOLARIS will be 15 years. A fuel reserve and an attitude-correction system will enable the station to stabilize itself perfectly about its three axes to such an extent that the microgravity on board will not exceed g/100,000--an essential condition for the success of metallurgical experiments.

Periodically coming to the station, and mooring to it, will be "transport modules" launched at the rate of two per year (or a total of 30). These modules will also be propelled by Ariane IV rockets, and their coupling to the station will be accomplished automatically (the differential velocity at contact will be lower than 1 centimeter per second, which is very close to the pace of a snail!). Once the coupling has been effected, a remotely controlled manipulator fixed abroad SOLARIS will take hold of the payloads and install them in their operating positions. Three types of transport module are planned: one large one, 3 meters high and 3.2 meters in diameter, weighing 3,400 kilograms; and two small ones of different shapes, weighing 700 kilograms and launched in groups of four.

When the experiments have ended, the payloads will be brought back to the docking point by the remotely controlled manipulator and will then follow a return sequence which is completely conventional: unmooring of the module, orientation by means of small attitude rockets, ignition of the retrorocket, separation of the reentry vehicle, properly speaking, opening of four parachutes, and landing in the sea off the coast of French Guiana. The area in which it falls will be an ellipse of 12 kilometers by 20--hence small enough to make recovery easy.

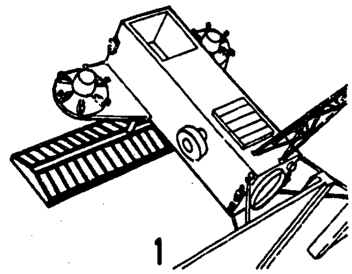
The first of these recovery operations is planned for the end of 1991 or the beginning of 1992. Certainly that will be a memorable data in the history of Europe, for it will denote full and total accession by the Old Continent to the mastery of space.



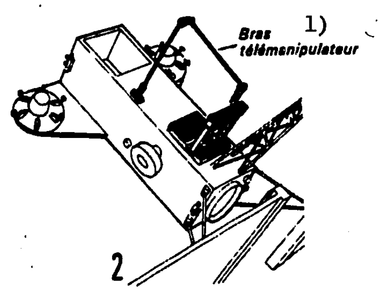
Key:
1. Ariane IV nosecones
2. SOLARIS station
3. Four small modules
4. Large module

In the course of successive launches, the nose of the Ariane IV rocket could be occupied by various elements of SOLARIS: the main platform, which weighs 5 tons (1); groups of four small modules, each weighing 700 kilograms (2); and a single large module of 3.4 tons (3).

THREE EXAMPLES OF ACTIVITIES ON BOARD

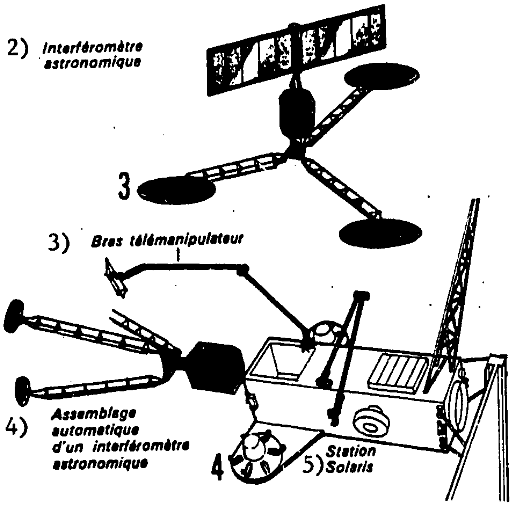


Among the different applications of the SOLARIS station, some, such as observation of the Earth by means of a field synthesis radar (1) proceed in autonomous fashion, whereas other,



Key:
1. remotely controlled manipulator arm

such as the metallurgical experiments, require the intervention of remotely controlled manipulator arms: here is seen the introduction of an experimental component into the appropriate compartment (2). Others necessitate still more elaborate construction before they can operate. Such is the case with radio observation of stars with small angular separation:



Key:
2. astronomical interferometer
3. remotely controlled manipulator arm
4. automated assembly of an astronomical interferometer
5. SOLARIS station

the astronomical interferometer (3) which fulfills this function consists, in effect, of three receiving antennas which must be assembled in advance and deployed in place automatically by remotely controlled manipulator arms (4).

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SCIENCE POLICY

UNITED KINGDOM: CURRENT TRENDS IN R&D REVIEWED

Paris LE PROGRES SCIENTIFIQUE in French May-Aug 81 pp 51-65

[Article: "Current Trends in Technological Research and Development in the United Kingdom," prepared by the scientific service of the French Embassy in London, May 1981]

[Excerpts] In the United Kingdom, as elsewhere, research is often recognized as a way to relieve or resolve current economic difficulties. For many countries (USA, Japan, FRG) the primary concern remains energy supply, followed closely by the necessity to innovate in order to preserve technological supremacy--a supremacy which is being more keenly contested daily by countries in process of industrialization.

The United Kingdom is a special case. It is the only large industrial country which has been independent in energy for several decades, and thus is not impelled to make any special effort in this area. For a number of years British industry had a huge protected market, which dispensed with the need to pursue innovation in order to prevail in economic competition. The energy limitation is less important in the United Kingdom than elsewhere; the stimulus for innvation is also more recent. In regard to scientific programs, this situation translates into excellent basic research but less well developed finalized research than in other countries, though compensated by a fine coordination between university and industry, no doubt better than in France.

The budget for the current fiscal year which began on 1 April 1981 has just been published. Table 1 shows the breakdown; it reveals significant increases for agriculture (+33.9 percent) and industry (+31.8 percent). The energy budget only increases by 16.5 percent, hardly compensating for losses due to inflation. The average increase is 23.7 percent for civilian research and 12.8 percent for military. The United Kingdom will thus spend 3.3 million pounds in 1981 for public R & D.

Table 1
TABLEAU
Research Development
Recherche et développement
(Supply estimates 1981)

£ '000

Ministère **Ministry**	1980-81	1981-82	Variation Δ %
Ministry of Agriculture Fisheries and Food	**62 053**	**83 133**	**+ 33,9**
Ministry of Agriculture and Fisheries for Scotland	22 778	29 118	+ 27,6
Civil Service Department	118	108	— 8,6
Customs and Excise	40	50	+ 25
Ministry of Defence	1 493 446	1 683 621	+ 12,8
Ministry of Education and Science	622 893	787 933	+ 26,5
Department of Employment	8 874	9 418	+ 5,6
Department of Energy	201 163	234 445	+ 16,5
Department of the Environment	46 514	46 692	+ 0,4
Foreign and Commonwealth Office	79	85	+ 7,6
Forestry Commission	2 589	3 164	+ 23
Health and Social Security	26 030	32 330	+ 24,2
Home Office	9 067	9 904	+ 8,8
Industry	**231 056**	**304 631**	**+ 31,8**
Office of Population Censuses and Surveys	1 961	1 521	— 22
Ordnance Survey	589	458	— 22
Overseas Development Administration	25 385	23 656	— 7
Property Services Agency	10 052	9 515	— 6
Public Record Office	(21)	(215)	(+ 1 000)
Scottish Development Department	388	387	0
Scottish Economic Planning Department	47	56	+ 19
Scottish Education Department	1 223	1 517	+ 24
Scottish Home and Health Department	3 111	4 844	+ 53,7
Scottish Office	3 545	3 882	+ 9,5
Department of Trade	4 123	5 652	+ 37,1
Department of Transport	22 221	24 583	+ 10,6
Department of Treasury and Subordinate Departs.	452	395	— 13
Welsh Office	1 579	1 538	— 2,5
Total	**2 801 397**	**3 302 851**	**+ 17,9**
Dont Recherche civile **Civilian research**	1 308 m£	1 619 m£	Δ = + 23,7 %
Recherche militaire **Military research**	1 493 m£	1 683 m£	Δ = + 12,8 %

National Research and Development Policy

Under the present organization, product of the Rothschild reform which aimed at administering relations between scientists and the technical ministries, Parliament votes the budget for basic research, which is presented by the Department of Education and Science (science vote). The funds are then divided up among five of the research councils: Science Research Council (SRC), Medical Research Council (MRC), Agricultural Research Council (ARC), Natural Environment Research Council (NERC), and Social Science Research Council (SSRC). The Advisory Board for Research Councils (ABRC) proposes the criteria for allocation of the funds.

Table II shows the current-year allocations to the five research councils as well as the expenditures of each research council by budget category, i.e.:

Universities' own laboratories and other associated units and support to universities through: contracts; placing at their disposal heavy equipment in the council's own laboratories; participation in international programs; maintenance grants for training of researchers.

TABLEAU II

(1) **Dépenses des Conseils de recherches par type d'activité en 1979-1980**

(2) en millions de Livres Sterling

	ARC	MRC	NERC	SRC	SSRC	Totaux (8)
(3) Contrats de recherche	2,2	19,5	7,2	44,4	5,4	78,7
(4) Laboratoires et unités de recherche	23,5	27,6	23,0	57,6	0,5	132,2
(5) Bourses de formation	0,3	4,5	3,4	24,1	9,3	41,6
(6) Participation aux programmes internationaux		1,5		43,1		44,6
(7) Administration - Divers	3,6	4,2	2,8	6,3	1,6	18,5
(8) Totaux	29,6	57,3	36,4	175,5	16,8	315,6

Key:
1. Expenditures of the research councils by type of activity in 1979-1980
2. In millions of pounds sterling
3. Research contracts
4. Laboratories and research units
5. Training grants
6. Participation in international programs
7. Administration--various
8. Totals

Applied research is managed by the technical ministries (there is no inter-ministerial budget). These ministries are considered as clients undertaking research projects to meet their own objectives through laboratories, selected in principle by them, and treated as "contractors." This system has apparently worked well for some ministries (agriculture) but had to be dropped recently by others (health). The technical ministries have their own laboratories (Industrial Research Establishment) but delegate a large proportion of their more basic projects to the research councils. At the highest level, a committee, the Advisory Council for Applied Research (ACARD), plays a role similar to that of the ABRC.

The research is carried out either in the universities or the research councils' own laboratories.

Financing for the universities is handled by a special body, the University Grant Committee: the allocated sum is intended to meet teaching and research expenses. It is up to the university to see to the maintenance and operation of the laboratories, and to undertake with its own funds research of a quality that will persuade the research councils to award it contracts; this is the "dual system," an arrangement which works well when there are sufficient resources on both sides. However, that is currently not the case, since the present government wants to significantly reduce the budget of the universities and decrease the number of students. It is likely that the big universities (Oxford, Cambridge, London, Edinburgh) which have their own funds, will not be much affected by these financial cutbacks; but the recently established small universities which only have government subsidies will have difficulty surviving.

Biomedical Engineering

Biomedical engineering deals essentially with medical instruments (analyzers, detectors, microscopes, etc.), products relating to biology, and internal and external prostheses.

Private Sector

Since medicine is nationalized in the United Kingdom, the National Health Service is the principal customer for this equipment, which is produced almost entirely by the private sector. Last year, the NHS spent about 1 million pounds for purchases in this sector, which is a very favorable one for the UK. In 1978, exports (200 million pounds) exceeded imports (150 million pounds). Production in 1979 totaled 90 million pounds, of which two-thirds was exported. The R & D in this sector is estimated at about 3 million pounds, or an average of 6 percent turnover. Table IV portrays the situation in the other sectors (biomechanical, mecanotherapy, sterilization and opthalmology equipment).

Table III

	1979 Production (million pounds)	Degree of Penetration (percent)	Position	Percentage Exported 1979
Medical imagery	58	46	Excellent	87
Medical electronics	31	58	Excellent	60
Pacemakers	--	100	Very poor	0

Table IV

Other sectors	Imports	Exports
	In millions of pounds sterling	
Biomechanical equipment	18.8	11.5
Mechanotherapy equipment	7.6	10.8
Sterilization equipment	1.5	2.2
Opthalmology (glasses, lenses)	1.5	5

In the biomedical sector, we should note the remarkable technical success (which earned a Nobel prize) of the EMI Scanners (600 tomographs sold for export in 1979). Seventy scanners are in use in the UK, or 1.3 per million inhabitants (the corresponding figure for the United States is 6.7 million). Following financial difficulties, Thorn EMI recently turned over its medical activities to GE (U.S.). On the other hand, a recently established British company, Medical Engineering, is planning to commercially produce scanners at a very low cost price.

British activity in the biomaterials sector has thus far been very slight.

Public Sector

Activity is divided among the Medical Research Council, the Science Research Council, and the Department of Health and Social Security, but it is difficult to establish precisely how much is being spent for these purposes;

The MRC does not spend more than 1 percent of its budget on this field, most of its resources going to the Clinical Research Center, which has two computerized services, one for market information on instruments and materials, and the other for published material;

The SRC has identified three priorities (but spends little on these areas): materials used in dentistry, internal prostheses (polymers, ceramics, heart valves), external prostheses (hemodialysis, oxygenators, contract lenses, etc.). Jointly with the MRC, the SRC tries to promote development of magnetic nuclear resonance equipment. In 1979-1980, the SRC and MRC spent about 400,000 pounds on the area of internal prostheses.

The DHSS is the most involved in this area: it spend 2.7 million pounds in 1980, of which 540,000 pounds for the research on prostheses and rehabilitation of handicapped people. For example, the following projects are underway: medical imagery by magnetic nuclear resonance; a Coulson biological analyzer; a cyclotron for neutrotherapy; a device to make kidney grafts possible; a photorefraction technique for early detection of sight problems in children; production of synthetic tissue from carbon fiber, and flexible contact lenses.

Biotechnology

An ad hoc working group presented a report to the government in August 1980 concluding that the UK had done very little in the area of biotechnological innovation and that investments in this field were too small compared to other countries. The working group recommended increased financing of public research in this field, developing scientific capability by training more researchers, and establishing a company in the public sector to benefit from research potential. The government's reply, recently published as a white paper, was a strong disappointment to the scientific community: no additional funds were allocated for research or aid to small enterprises, other than a suggestion to better coordinate the efforts of the National Research Development Corporation (NRDC) and the National Enterprise Board (NEB). The responsibility for converting discoveries of useful products and services of possible commercial value is left to industry. However, the Center for Applied Microbiology and Research at Porton is to be available to industry and serve as an exchange center.

The regulations on security control of experiments involving genetic recombination have been eased for experiments with lowest danger potential classified in physical confinement category I, or experiments involving a reliable microbiological practice; this applies in fact to 99 percent of experiments. It is no longer necessary to notify the Genetic Manipulation Advisory Group and the Health and Safety Executive on a case-by-case basis. The decision as to whether experiments fall into these categories will be up to the local security committees.

Public Sector

It is estimated that the research councils spend about 3 million pounds for biotechnology, to which should be added a few contracts originated by the technical ministries and financing of research by the Public Health Laboratory Service in the Center for Applied Microbiology and Research.

There are a number of leading teams scattered in various centers, institutes, and universities (Cambridge, London, Edinburgh, Glasgow, Bristol, Warwick, Norwich and Cranfield Institute of Technology).

The SRC, which for a decade has been financing basic research in restriction enzymes--particularly at Edinburgh University (Professor Murray)--plans to increase its involvement in the coming 4 years and establish two "bio-centers" (teams located in universities) whose purpose will be to cooperate with industry in biological engineering.

At the MRC, basic research on the cell at the molecular level has reached the stage of possible usefulness to clinical medicine: work on molecular sequences, genetic manipulation, and production of monoclonal antibodies (research being conducted particularly at the Cambridge Laboratory of Molecular Biology). The MRC is also financing work on plasmids which are resistant to medicines, studies which could lead to synthesis of antibodies and research to develop techniques for prenatal diagnosis of congenital problems (for example, Thalassemia). In 1978, the research capability was estimated at about 380 persons, of whom 56 were in the MRC.

In 1978 the ARC began a program of research into genetic manipulation applied to food agriculture. The target of 50 researchers set at that time has been achieved; the teams have gone to various institutes appropriate to the scope of their projects, and the programs have been laid out for the ANC as a whole. The objectives of the research are improvement of vegetable varieties (development of somatic hybrids), combat of certain animal diseases (production of antigenic proteins using bacteria in which a viral plasmid has been cloned), processing of microorganisms of value to food agriculture (bacteria, yeasts).

The NDRC, ANVAR's counterpart, has invested about 3.5 million pounds. It is currently financing 22 projects: 8 in genetic engineering, 6 in antibiotics, 6 in potential industrial applications using microorganisms and enzymes, and 2 for vaccines. The NRDC has little cooperation with the pharmaceutical industry, which conducts its own R & D. In the next few years, investments are to be directed to the food industry.

The Center for Applied Microbiology and Research (CAMR) at Porton, which is financed by the Public Health Laboratory Service (PHLS) and which was recently reorganized, is particularly well-equipped for physical isolation of dangerous pathogens (category A, such as Lassa virus, measles...), culture of microorganisms in large quantities, and fermentation. It will be assigned an increasingly important role in biotechnology and obtaining contracts with industry. The biotechnical projects include production of human growth hormone for Kabi-Vitrum, development of vaccines by genetic engineering, study of hosts other than E. coli (yeasts--thermophile bacteria) and biodegradation of effluents by bacterian enzymes.

Main Developments

Interferon: preparation of a monoclonal antibody against human interferon; marketing by Celltech; cloning of interferon genes α and β ; Professor Burke's team has succeeded in cloning interferon genes α and β in a plasmid of E. coli (cloned genes are not yet capable of expression).

Human growth hormone: production on a large scale at CAMR of human growth hormone for Kabi-Vitrum using E. coli containing genes of the hormone.

Vaccines: development of vaccines by genetic engineering at CAMR (work in progress, with Professor Murray of Edinburgh, on vaccine against viral hepatitis--vaccine against smallpox).

Taline: at Kent University (Professor Stacey), research to produce an E. coli (or other bacteria) capable of synthesizing a protein, Taline, which is found in fruits of tropical plants and is 3,000 times sweeter than cane sugar (cooperation with Tate & Lyle).

Cooperation in biotechnology between the University of Compiegne and the Cranfield Institute of Technology: establishment of a joint unit at Cranfield working on biotechnology. The research will be done under contract for public services and industries. It will involve development of the methods and requirement for exploiting industrial and agricultural by-products and biomass (obtaining nonconventional proteins, fuel and food-agriculture engineering).

Improvement of plant species: use of gene cloning in bacteria or yeasts for various projects to improve plant species, including: somatic hybridization of two varieties of petunia; plant regeneration through modified protoplasms for the species of primary agricultural interest (potatoes, grains, grasses); modification of the properties of grain proteins; increase in plant resistance to viral diseases and sensitivity to antibiotics.

Center of Biotechnology at the Imperial College of Science and Technology (under the direction of Professor B. Hartley): the center coordinates the activities of various Imperial College departments, particularly the biochemistry department, and also outside branches (for example, the Center for Applied Microbiology and Research and the biotechnology unit on plant cells at Sheffield). There are numerous contracts with industry (in 1981 their value totaled 100,000 pounds) but most of them are confidential.

The research focuses on the following topics, among others: large-scale industrial fermentation processes (interpretation of laboratory results in fermentation viable in the 25-1,000 cubic meter range).

A contract has been reached with Biogen for large-scale (3,000 liters) production of leucocyte human interferon from recombined E. coli.

Also underway are projects on the following: use of continuous culture for selection of clones in presence of a mutagene; large-scale production of metabolites (isolation of intra-cellular enzymes); simultaneous isolation of several enzymes (large-scale production: 70 kg) using thermophile bacteria more stable than stearothermophiles; cloning of genes and expression in yeasts (facilitating expression of foreign genes in organisms); genetic manipulation of thermophile bacteria to produce solvents and chemical products in large quantities; biological control of plant diseases by replacing chemical products as control agents with microorganisms or their products (experiment on an agronomical scale).

Private Sector

According to the "chief scientist" of the Ministry of Industry, expenditures by industry are probably about the same as those of the public sector. Biotechnology is not a new development in the UK, particularly in certain chemical, pharmaceutical, and food-agriculture industries. For example: Glaxo and Beecham, producing penicillin and semi-synthetic penicillins; Wellcome Foundation Ltd., which is preparing interferon from lymphoblasts; Imperial Chemical Industries (ICI): production of protein from methanol for animal feed.

The yield of "Pruteen" has been improved through the introduction into the bacteria, methylophylus methyltropus, of a coding gene for an enzyme which will catalyze the reaction more effectively. Experiments are underway to produce

PHB (polyhydroxbutyrate) which resembles synthetic polyesters used for plastics employing a process similar to that for production of Pruteen but with new strains of bacteria. In fact, the PHB synthetized is too fragile, but the ICI team is trying to modify either the polymer itself or the bacteria used (alcaligenes entrophus) through genetic engineering to obtain a polymer which will be less fragile and more flexible.

Tate and Lyle: conversion of hydrates of carbon and alcohol using micro-organisms; Rank Hovis McDougall has received the Agriculture Ministry's authorization to proceed with development of a mycoprotein obtained from grain and intended for human consumption; Searle (United States) in the UK: production of interferon from fibroblasts in a pilot plant constructed in the UK and flu vaccine (at High Wycombe, first phase of cloning a gene of the flu virus in a bacteria).

Establishment of Celltech (1980)

The new British company has a capital of 12 million pounds financed by NEB (44 percent) and the remainder by four companies of the city. It has its own laboratory at Slough and is to serve as an interface between research and industry. Celltech has signed an agreement with MRC giving it access to research of its laboratories, particularly in the field of hybridomes and genetic recombinations by ADN. The royalties MRC receives will be used to finance research, in addition to that funded by its own budget, and will become the "Calltech Fund," controlled by a subcommittee composed of council members. Marketing of Calltech's first product has been announced. It is a monoclonal antibody against interferon developed by Dr Secher at the Cambridge Laboratory of Molecular Biology in cooperation with Professor Burke at Warwick.

Scientific and Technical Information (Data Banks)

Scientific and technical information is disseminated in the UK by two main services:

The British Library Research and Development Department (BLRDD), which is the equivalent, in part, to our National Library. The British Library is a public institution under the authority of the Ministry of Education and Science.

The Technology Reports Center (TRC) is a technical information center under the Ministry of Industry.

While the TRC's activities are exclusively technological, the BLRDD's field of operation is far broader with resources to match. Thus, in 1979 the BLRDD spent 1.3 million pounds both on activities by its own staff of 32 people and on contracts with the universities. It is estimated that the TRC has only about one-tenth of those resources.

The BLRDD's primary objectives are set by an interministry committee on scientific and technical information, the ICCSTI (Interdepartment and Coordinating Committee for Scientific and Technical Information), with the BLRDD providing the secretarial support. These objectives have been elaborated into priority research projects, specifically bibliometric research, computer indexing, processing of chemical data, and methods for evaluating index systems. Those priorities led to conclusion of contracts for 1979 as follows:

Basic research (180,000 pounds); example: methods of data compression (University of Sheffield).

Advanced techniques (53,500 pounds); example: integration of bibliographic material into the British videotex system PRESTEL (Langton Information System).

Thematic research (23,600 pounds); example: comparative evaluation of toxicological information sources (Royal Postgraduate Medical School).

User research (250,000 pounds); example: evaluation of the teaching "package" in information science. (Newcastle Polytechnic).

Two other priorities obtaining a significant budget allocation are the program to improve management of scientific or nonscientific libraries (378,000 pounds) and the program for development of research and information in public libraries (128,000 pounds).

Finally, what is the UK's position in relation to its main competitors in regard to R & D of data banks? The following main institutions are in the best position:

Development of data bank software: universities: Aberdeen, East Anglia, Edinburgh, Sheffield, Strathclyde, London School of Economics; industry: IBM (Peterlee Center), Honeywell, ICL.

Development of data bank hardware: this is done almost exclusively in the industrial context: IBM, Honeywell (IDS System), and finally ICL, which has been able to develop its hardware in two directions, one being mass storage, with its CAFE (Content Addressable File Store), applicable also to the electronic annual, and the other relating to architecture with its IPA (Information Processing Architecture).

If you use the number of publications selected at international conferences as a criterion for international ranking, the UK does not rank high since only one British paper has been accepted during the three latest international conferences on data banks (the IFIP-TC2 congress in Venice, the Rio de Janeiro conference, and the Paris conference in 1980). However, if you believe that the best measure of development effort in this area is ultimately the actual number of data banks established in the UK, then you should consider the picture presented by the following list of British data banks, most of which are accessible to Euronet/DIANE: Aqualine (water); BHRA Fluid Engineering; BNF Metals Abstracts (nonferrous metals); CAB Abstracts (agriculture); Conference Proceedings Index; FSTA (food science and technology); Geoarchive (geology); Inspec (electronics, computers, physics); IRL Life Sciences collection; LISA (library and information science); Pestdoc (pesticides); PIRA (paper and printing); RAPRA Abstracts (rubber and plastics); Ringdoc (pharmaceuticals); Surface Coating Abstracts; UKC MARC; Weldasearch; World Textiles; WPI (patents).

This leads us to conclude that computer information technology in the UK is at least as advanced as that in France.

Finally, it is important to note that the TRC is a computerized center for technological information catering to companies. The center depends on existing data banks, British (e.g. INSPEC), American (e.g. NTIS), or even European (e.g. ESA banks), and itself produces a technical information data bank R & D Abstract.

Telecommunications

In many respects, telecommunications development in the UK is comparable to what can be done in France. Two major elements contribute to this development, one, public, is the Post Office, the other, private, is the whole group of major telecommunications companies, GEC, Plessey, STC. The viability of the one and the prosperity of the others are closely linked.

R & D Resources

The following table breaks down the Post Office R & D budget for 1980. The approximate breakdown is given for major objectives, then for the major technical options.

Table A
Post Office R & D Fund Commitments
Breakdown by Objectives

	in millions of pounds sterling
Improvement of present techniques	13.7
Development of new systems	56.3
Long-term research, basic research	17.3
Advice, consultance, studies	8.3
	95.6

Table B
Post Office R & D Fund Commitments
Breakdown by Technical Options

	in millions of pounds sterling
Substitution	54.3
Transfer	18.1
Customer equipment	10.9
Components, materials	6.2
Technical advice	2.5
Studies, consultance	3.6
	95.6

The first conclusion we can draw is that the Post Office's R & D effort is comparable in volume to that of its French counterpart, Post and Telecommunications.

In the UK private sector, GEC, Plessey, and STC share the telecommunications market, with sales of 2.5 billion, 648 million, and 436 million pounds respectively. Their activities are closely tied to the public markets. It is obviously very difficult to find out what resources these companies devote to R & D. However, it appears that British companies spent 525 million pounds in 1978 on components and communications.* We can conclude that British companies spend at least 100 million pounds on their telecommunications R & D effort.

Main Lines of Development

It appears that the main lines of development are the same im nature to those of France.

Projects already in the industrial phase:

Fiber optics--a 450-km network is under construction and should be operational by 1982; radiotelephone--a project to expand from 30,000 to 1.5 million users; telephone exchanges--with development of SYSTEM X time switches; telecommunications satellites--development of the Madley station at a cost of 7.5 million pounds; telecomputer--development of the PRESTEL videotex system, already in operation with 6,000 subscribers, tele-conferences, tele-alarms, etc.

Projects in R & D phase:

Optic transmission: rapid data transmission 565 million bits/sec; facsimile transmission; microelectronics--"design" of specialized LSI circuits (e.g. CODEC); microprocessor-equipped local switchboards.

The Post Office's R & D effort in telecommunications has increased significantly in the last few years (55 million pounds in 1975, 96 million in 1980). Despite

* Business Monitor-MO 14--"Industrial Research 1978."

pessimistic predictions for this industry (cf. "Electronic Telecommunications in the UK to 1985" Bureau Carsen Sweeny), the UK nevertheless finds itself in a good position, particularly with respect to France. We should point out that the British telecomputer program has reached a state of advancement which is also very competitive.

Automobile Research

The international symposium on automotive technology (ISATA 80) held in Turin in 1980 heard 16 British and 4 French papers. The British companies represented were: Ford, Shell (UK), G. Cussons, Lucas, Leyland Vehicles, British Leyland, GNK (UK), SDRC Engineering, and BP. The universities and research centers represented were: University of Southampton, London (Queen Mary College) and UKAEA.

The disproportionate representation of the British compared to the French is not immediately explainable. We do know that companies in the best position are not always eager to talk about their operations at international congresses after the point when the industrial stakes become important. However, this illustration does give an idea of the more important British companies in automobile development. In 1978, the companies spent 128 million pounds sterling for auto development: the most striking result was the unveiling in 1980 of EL's mini-metro, whose fuel consumption figures are very close to those of our R5.

It is clear that auto vehicle development (gasoline engines) is carried out almost exclusively by the private sector. Of the 128 million pounds spent in 1968, 5.5 million pounds were provided by the British Government.

British research is evidently oriented to parallel that of its principal competitors:

Auto electronics: Example 1: Lucas is developing specialized pressure detectors as well as air loss detectors; Example 2: Shell Research is developing electronic lighting.

New materials/substitute materials: Example 1: Lotus is using composite materials in its racing models; Example 2: Ford and Fiber Glass have jointly developed a new polyester intake manifold for cars.

Testing/security: Example 1: BP is developing computerized test benches for engines; Example 2: The MIRA (Motor Industry Research Association) is working on vehicle security.*

Materials and aerodynamic engineering: Example 1: The UKAEA is analyzing the engineering limitations of materials (with application to vehicle chassis); Example 2: The MIRA is developing new aerodynamic shapes.

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* The Research Associations are equivalent to our technical centers. The MIRA spends more than 3 million pounds per year on automobile development.

Finally, we should mention one more important element, electric vehicles: the Department of Industry is providing 3 million pounds sterling to assist a development program for electric vehicles. This research seems to have made more progress in the university context. The following table shows the major university teams involved in these projects.

Universities	Projects (applied to electric vehicles)
Manchester, Nottingham, Sussex, Warwick	Linear motors, synchronous motors
Bristol, Cranfield, Manchester, Nottingham, Leeds, Newcastle	Electric motors
Cranfield, Imperial College, Manchester, Newcastle, Nottingham, Leeds, Sussex, UMIST	Reliability
Bristol, UMIST, Manchester, Nottingham/Leeds, Warwick	Energy storage
Leeds, UMIST	Batteries, chemical conversion, economy, marketing

We should add to these teams all the manufacturers who are involved mainly with chemical transformers, for example: Chloride, partner of Chrysler, and Lucas, partner of Bedford, are developing electric vehicles. These manufacturers generally form partnerships with a vehicle producer.

The position of the British automobile industry is hardly bright: 98 percent of production is divided among four groups: one British group (British Leyland) and four American (Ford, Vauxhall, (GM), Chrysler), but in fact 50 percent of Fords sold in the UK are assembled in Spain, the FRG, Belgium and Ireland. British Leyland is, therefore, fighting for the survival of the British automobile industry.

By comparison with this bad situation, the automobile equipment sector is in an excellent position; the major manufacturers in this sector long ago realized that they had to cross frontiers; they are established in Europe and the United States, and have undertaken a profitable diversification into the aeronautical field.

Fine Chemistry

Chemistry in the UK is a prime sector, whether in scientific planning or manufacturing.

Three organizations are involved: the Science Research Council, the National Research Development Corporation, and the Department of Industry.

The SRC has defined the priority sectors, and polymers leads the list. The SRC's policy is twofold: it assists in acquiring expensive and sophisticated equipment, and funds specific research projects. For example, it has financed the purchase of high-isolation RMN spectrometers for the universities of Edinburgh, Sheffield and Norwich, and Queen Mary College in London; Raman spectrometers and lasers for Cambridge, Oxford, Nottingham, Bristol, and Southhampton; and high-resolution liquid chromatographs to develop methods for producing antibiotics and vitamins. It is actively supporting work at Oxford on synthetis and biosynthesis of lactary antibiotics, and in general all the activities of the "Oxford Enzyme-Group."

As for the NRDC, it is trying to convert laboratory project achievements to the industrial level, and specifically is aiding the teams at Leeds, Surrey, Herriot Watt, and Newcastle in their work on lactamel. Also, it is promoting work on "Charcoal Cloth" and on phosphorus monocrystals or gallium arsenide.

The Ministry of Industry is devoting special attention to catalyzers, providing grants specifically to the Harwell center (500,000 pounds) which is studying in detail the role of catalyzers (surface state, purity of materials, and geometric effects, etc.).

Industrial Sector

The industrial sector is dominated by the major companies (ICI, Shell, Courtaud, etc.) but ICI is the real leader and also the example and the authority. The British chemical sector deserves close attention.

ICI, which is involved in all areas (dyes, pigments, pharmaceutics, catalyzers, and new plastics), is one of the shining lights of British industry (4.5 million pounds of products sold in 1980). It is second in Europe behind the FRG. It invests from 10 to 12 percent of its turnover (5 percent in France). Between 1971 and 1975 its turnover increased by 80 percent, and it succeeded in placing "key men" in a number of important strategic posts (chief scientist of the Department of Industry, the Department of Energy, chairman of the SRC, etc.). ICI is a world which it is difficult to penetrate; it is also a model for university-industry relations.

Other, smaller companies are more specialized in pharmaceutics; Beecham and Glaxo had a turnover of 1 million pounds in 1980 and Wilson and Fisons are also involved in pharmaceutics and dyes.

Overall, the private sector spends 500,000 pounds for R & D, of which one-third is for pharmaceutics, which is an excellent sector for the UK, with a higher productivity than the U.S. counterpart.

Overall, fine chemical products for pharmaceutics are in a state of stagnation: 237 million pounds in 1977, 247 million pounds in 1980. Fine plastics totaled 615 million pounds, and dyes about 230 million pounds (3.1 pounds per kilogram). Briefly, the main research targets are as follows:

ICI: replacement of petroleum products by products derived from coal or gas, fermentation, bioengineering;

Shell: thermoplastics, resins, elastomers, colloidal chemistry;

Courtaud: chemical textiles, carbon fibers.

The chemical sector in the UK is at a crossroads. More than any other sector, it has pushed investment, at the risk of having overproduction in some areas. Should it continue to invest in order to maintain its lead over its European rivals, or should it stop its expansion, thereby risking being overtaken when the North Sea oil price becomes the same as that of Middle East oil? One of its largest handicaps currently is the high price of its raw materials (and secondarily its relatively modest productivity).

The British Space Program

A space program has two elements: production and use of launchers, and production and use of satellites in orbit.

Launchers

The UK has deliberately bypassed the launcher phase in order to concentrate on satellites. After giving up development of an independent strike force, the UK stopped work on developing the "Blue Streak" missile and induced the European countries in 1961 to join the "European Launcher Development Organization (ELDO) to develop a heavy launcher (1 ton in orbit), thereby seeking to profit in a European context from the work it had done in the military field. At the end of 1968, for financial reasons, the UK left ELDO, stopping its contributions and taking Italy with it. In 1972, ELDO and ESRO (European Space Research Organization) were dissolved.

Satellites

The UK has played an active role in this area within ESRO; it also plays an active role in the European Space Agency (ESA).

It has very good scientific and technical capabilities in the satellite field. From 1962 to 1979, it launched 13 satellites, 4 military using Thor Delta rockets (of these 2 failed), and 9 scientific. Of the 13 satellites, 4 were bought from the United States and the others were produced in the UK.

The two big industrial companies involved in producing satellites are British Aerospace and GEC Marconi. They are both members of the three European consortiums STAR, MEST and COSMOS.

Under current programs, ARIEL 6, a satellite launched recently for scientific purposes, will be the last all-British space capsule. There has been a change recently in the British attitude on satellites. Until recently, they showed little enthusiasm for the European ambitions. A study by the "Central Policy Review Staff" apparently convinced the British Government that it could no longer stay aloof from the progress of this technology. Since that time (autumn 1980), the British Government has shown new interest in the European satellite programs; regretting that they were not involved in the French-German direct TV program, the British organized within ESA the ELSAT project by enlisting those European countries not associated with the French-German program.

They are showing lively interest in the Arabsat issue, and relations between British Aerospace (BA) and Matra are excellent, though clouded by the Anglo-American discussions on replacement of Skynet (geostationary military satellite).

The British satellite industry intensively researches the international markets. BA has been the principal subcontractor for Hugues Aircrafts [as published] for 12 Intelsat satellites, and has played the same role for 4 Comsat satellites; it has been the principal contractor for GEOS and was heavily involved in COSB. It is also the principal contractor for OTS (Orbit Test Satellite) as the forerunner for ECS (European Communication Satellite) to be launched by Ariane in 1982. Also, two Marec satellites which the UK regards as very important are being built by the European MESH consortium under the leadership of British Aerospace. As for Spacelab, whose completion has been put in doubt by the United States, British Aerospace is to construct discs and platform assemblies. BA is also working on an order worth 13 million pounds from ESA as the European participation in the telescope to be carried by NASA, and production of a very high sensitivity photonic detector. More recently, the BA-Matra consortium was granted a contract to build a telecommunications satellite.

In regard to scientific research devoted mainly to astronomy and ionosphere projects, the British national effort has been decreasing steadily in favor of cooperative programs. Nuclear physics is one of the area in which the UK has decided, due to limited financial means, to work only through international cooperation.

In conclusion, the British space program is undergoing a reappraisal, since the UK does not want to be left out of the European achievements, particularly the French-German.

Bilateral Scientific and Technical Cooperation Between the UK and France

This cooperation is not easy to encompass, since it has many aspects: some the subject of formal and official agreement between similar (or quasi-similar) organizations, others having developed at the level of research organizations and independent of any control. About 200 French scientists live in the UK for periods varying from 1 to 6 months. In 1981, there were approximately 80 researchers working under the following cooperative agreements: GNRS/Royal

Society (30); Foreign Affairs (young engineers 19); CNRS/SSRC (8); INRIA (6); INSERM/MRC (3); CNRS/MRC (2); GNRS/British Council (2); various others (5).

Of the total 29 were from the engineering field, 15 biomedical, 13 mathematics-physics-chemistry, 10 social sciences, 6 computers, and the rest (6) from various sectors.

The average stay of French or British researchers in the UK or France is 5 to 6 months. For every two French researchers who come to the UK, one British researcher goes to France.

The British come to France to study the following: human sciences (51 percent); life sciences (22 percent); mathematics and physics (10 percent); chemistry (5 percent); LOS (land, ocean, space) (5 percent); other (7 percent).

The French come to the UK to study: human sciences (31 percent); chemistry (23 percent); life sciences (17 percent); engineering (12 percent); mathematics and physics (9 percent); LOS (3 percent); others (5 percent).

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