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European Union

Science, technology and European foreign policy: European integration, global interaction

Josephine Anne Stein

Co-operation in science and technology is a significant component of European integration and of the European Community/Union's relations with the rest of the world. Science and technology are themselves becoming ever more relevant to global issues and to international interactions that together exercise the world of diplomacy. However, linkages between international S&T co-operation and foreign policy in Europe are rarely explicit and certainly not systematic. This paper explores the ways in which European S&T co-operation developed in the context of international relations, both internal and external. It suggests ways in which Europe's multilateral, multicultural experience could inform the design of more widespread scientific and political co-operation.

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EUROPEAN INTEGRATION since World War II has been one of the most ambitious international undertakings in modern history, implemented through a variety of economic, political and other means, including co-operation in science and technology. Initially, S&T co-operation was closely associated with post-war reconstruction efforts aimed at rebuilding European science and modernising European industry.

However, the war had been a World War, with a global aftermath in which Europe also needed to redefine its relations with the nations of the world, including a growing number of former colonies. The USA, a wartime ally and former European colony, was influential in two ways: at first by encouraging post-war European scientific co-operation, and later, by stimulating European technological co-operation in response to American economic competition. Over time, European S&T co-operation with other nations, and with regions and international organisations, became an important component of European foreign relations with the rest of the world.

We now enter the 21st century at a time when trade and its socio-economic impacts, the environment, public health and perhaps most importantly security post-September 11 have assumed global proportions. The importance of linking scientific and technological knowledge with foreign policy has become increasingly evident, yet mechanisms for organising multilateral global scientific co-operation and international scientific advice are underdeveloped at best, and more typically embryonic or non-existent altogether. What are the prospects for utilising S&T expertise to underpin global international agreements, or for co-ordinating international research efforts to address common, global problems?

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This paper explores how science and technology co-operation relates to intra-European foreign policy (integration), and how European S&T relates to broader international co-operation (interaction). Europe is currently embarking on the next phase of its ambitious integration project, involving, *inter alia*, both co-ordination of science and technology through the European Research Area (ERA) and enlargement of the membership of the European Union (EU). At the same time, Europe is developing a highly complex set of relationships between the EU (and its constituent Member States, regions, institutions and industries), with partners around the world, often involving S&T co-operation or based on S&T-related issues.

It is one indication of the state of the maturity of European integration that the discourse has shifted from 'external relations' to 'foreign policy', while the European Convention has produced a preliminary draft Constitution for what may become the "United States of Europe" (European Convention, 2002). Science and technology have their role to play as the European Community (EC) assumes greater responsibility as an international actor, alongside and sometimes on behalf of its Member States. The interplay between science, technology and foreign policy has had tremendous significance both within and beyond Europe. This dynamic is set to intensify as the forces of European integration contend with Europe's place in a rapidly globalising world.

EU, science and technology: legal niceties

Contrary to widespread popular belief, the creation of the European Union did not supersede the EC, although the two are comprised by the same 15 Member States.[1] The Treaty on European Union (the Maastricht Treaty, 1993) established three "pillars", of which the European Community (or more technically, the European Communities), with its set of legal competences and institutions (the European Commission, the Council of Ministers, the European Parliament, and so on), is the first. The other two pillars, Justice and Home Affairs, and Common Foreign and Security Policy (CFSP),[2] are intergovernmental, with lesser roles for the EC institutions.

Science and technology policy fall largely within the domain of the EC,[3] which is responsible for the Framework Programme, S&T-related regulation and consumer protection, industrial policy and the Information Society, *inter alia*. Some aspects of foreign policy are part of the third, intergovernmental pillar, while others are covered by the EC; some related issues, such as immigration, come under the second pillar. In this paper, a distinction is made between the activities of the EC and the broader concerns of the EU, pending the outcome of the European Convention and the adoption of a Constitution for Europe.

The respective foreign policy responsibilities of the Member States and the EC, are complex, dynamic and often overlapping. For example, the EC has observer status at the United Nations but is party to over 50 multilateral agreements concluded under its auspices, in areas such as international trade and the environment. The EC is a member of the OECD (Organisation for Economic Co-operation and Development) along with each of its Member States. The Community co-ordinates development aid to third countries on behalf of its members. In external trade, the EC has exclusive competence and the Commission is responsible for negotiations on behalf of the Member States.

Foreign policy in the EU is even more complex, with the intergovernmental Common Foreign and Security Policy 'pillar' often being more visible than the EC's external relations activities. Indeed, it may have been the complexity of having both a CFSP High Representative (Javier Solana, appointed in 1999), and a Commissioner for External Relations (Chris Patten), in addition to the rotating Presidency of the Council and the Troika's role in international relations,[4] that prompted Henry Kissinger's famous rhetorical question, "When I want to talk to Europe, who do I call?".

So far as the main thrust of science and technology external relations is concerned, it is the Community 'pillar' through which co-operation agreements with third countries are reached. These agreements were initially based on Article 130n of the EEC Treaty for access to specific programmes under the Framework Programme, or Article 130q for general association (MacLeod *et al*, 1996). The Treaty on European Union modified the legal position by requiring Article 130m to be used in conjunction with Articles 228(2) and 228(3), which provide for consultation with the Parliament and a qualified majority in the Council. Provisions for S&T co-operation can also be included in more general agreements pertaining to, for example, trade, fisheries, and the environment.

The Euratom Treaty is the basis for the Community's membership of the International Science and Technology Centre in Moscow and the Science and

Technology Centre of Ukraine in Kiev, both of which were set up with the co-operation of partner countries in all parts of the North American, European and Far Eastern 'Triad' to provide work for former Soviet nuclear weapons scientists — an explicit foreign policy objective.

The European Commission currently has a diplomatic presence in 128 delegations and offices abroad, with a network of science counsellors posted around the world.[5] It maintains liaisons with various S&T-related international organisations (such as the United Nations) or their agencies (such as UNESCO (Educational, Scientific and Cultural Organisation) and the Food and Agriculture Organisation) or subsidiary bodies (such as the Global Science Forum of the OECD).

There is an External Relations Directorate General that forms part of the Commission services, but foreign policy is also conducted through the Directorates General for Development, Enlargement, Trade, and two covering aid. The Commission's own self-perception is that it has achieved relatively good S&T relations with developing countries, in comparison with other parts of the world.

If we were to make a full inventory of S&T co-operation agreements, two types are most prominent. The first are agreements with the 13 countries that have applied to join the EU; the second are those with industrial countries.[6] In the former case, these co-operation agreements are in accordance with enlargement policy; for the latter case, the EC uses such agreements as an instrument to gain access to knowledge in technologically-advanced countries as much as to combine resources in addressing problems of common interest.

The Treaty of Amsterdam, signed on 17 June 1997, sought to give Europe a "stronger voice in world affairs", strengthening the CFSP 'pillar', but the treaty did not have a significant impact on either the basic roles of the Community 'pillar' or on S&T-related policy *per se*. At this writing, it is not clear if the outcome of the Convention on the Future of Europe and associated inter-governmental negotiations will lead to some form of convergence between the foreign relations activities of the CFSP and Community 'pillars', thereby strengthening an 'EU face'. It is unlikely that Kissinger will find an immediate answer to his question, although it is possible that a 'gatekeeper' may be created to provide a single entry point to the full complexity of the EU foreign relations apparatus.

From its beginnings with the Coal and Steel Community in 1951, the integration process has come far as Europe stands poised to constitute itself as having a legal 'personality', with a written constitution and all this implies for future governance regimes. To gain some insight into European S&T relations with the rest of the world, it behoves us to examine how and why S&T co-operation developed as it has within Europe over the past half century.

Science, technology and European integration

European integration has proceeded in S&T, economic, cultural and political spheres through a great number and variety of means. Over time, European institutions and networks have emerged and developed in all these spheres, along with the progressive expansion of membership in the EC and the creation of the EU in 1993. In this section we focus on S&T-related, intra-European aspects of foreign policy, including relations between the EC and the candidate/accession countries.

(Re)construction of post-war European science

In the immediate post-war period, two complementary ideas gave impetus to a movement promoting greater political, economic and military unity in Western Europe, both of which took in scientific co-operation. The first idea, promoted most notably by the USA, was to protect Europe from Soviet expansionism. This took shape through the North Atlantic Treaty Organization (NATO), founded in 1949 primarily as a military alliance in partnership between European and North American countries, but with a separate programme devoted to scientific co-operation.

The second idea was to overcome the antagonisms of nationalism within Europe through economic co-operation and political integration. The Council of Europe, also created in 1949, was significant as a first forum where European scientific co-operation was encouraged. Though the Council of Europe itself was to have little direct involvement in scientific matters, the discussions it stimulated helped to lay the groundwork for CERN (European Organisation for Nuclear Research) and the scientific co-operation aspects of Euratom.

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Darriulat (1997) argues that there was a recognition at the time that scientific infrastructure in

Post-war intra-European scientific co-operation was established on a case-by-case basis, fulfilling objectives that were understood, if not necessarily officially articulated, as being more than simply scientific: European integration and European science went hand in hand

Europe needed to be developed after the damage of the War, and that there was a compelling logic to undertaking such work collaboratively. 'Big science' provided a natural focus. By the early 1990s, there were over 40 such examples of multilateral scientific co-operation in Europe (Holmfeld, 1993), either as self-contained projects or as European contributions to global-scale co-operation in areas such as nuclear fusion and space-based research. CERN provided an early successful prototype not only for its scientific achievements but for demonstrating the viability of a European entity in and of itself.

CERN was first proposed by Isidor I Rabi, an American physicist. As a delegate to the UNESCO annual conference in Florence in 1950, Rabi suggested creating one or more European nuclear research laboratories. The idea fell on fertile ground. Conceived of, and constructed, as a European project, CERN developed a European identity and an informal mission to compete with Brookhaven National Laboratory in the USA. Its establishment in 1954 was a result of both individual scientists and "'political' personalities" (Pestre and Krige, 1997) mobilising support for the project and enrolling sponsors.

The Euratom Treaty of 1957 included provisions for joint scientific research, training and technology transfer in the nuclear energy field. The Joint Research Centre began with a 1959 agreement to 'Europeanise' the Ispra research centre in Italy, with centres in Germany, Belgium and the Netherlands following suit by 1961 (Guzzetti, 1995). As the EC/EU enlarged and developed a broader range of research interests, the Joint Research Centre too has expanded and diversified, now constituting seven institutions based in five European countries.

It was CERN, however, that served as the primary inspiration behind numerous other European scientific organisations, many of which similarly benefited from the encouragement of American scientists, including through the prospect of scientific competition with US laboratories.

The European Southern Observatory (ESO) was founded in 1962 with five European members. According to Blaauw (1997), the favourable environment towards European integration was an important factor in the decision to include Germany from the outset. ESO drew upon the CERN model, and like CERN was set up in part to compete with rival US laboratories.

The European Molecular Biology Organisation (EMBO) was conceived in 1962 to reinforce the European scientific orientation of post-war collaborative science. Thirteen European countries (plus Israel) ratified a co-operation agreement in 1970, foreseeing that molecular biology would come to need the same sort of 'big science' infrastructure that was a more obvious prerequisite of modern particle physics as for CERN. Although three of EMBO's four founders were American, two were European émigrés; competition with US laboratories was again a major consideration (Morange, 1997).

The establishment of the European Molecular Biology Laboratory (EMBL), a daughter organisation of EMBO, was explicitly linked to the desire to secure European funding for research and to provide a training ground for European scientists who would take up positions at universities and laboratories throughout Europe. According to Kafatos (1997), the EMBL model, based on mobility, young researchers and interdisciplinarity in addition to international collaboration, is "one of the major contributions of EMBL to European (especially continental) science".

The Institut Laue-Langevin (ILL) was set up in part because French and German scientists needed a more powerful neutron source. However, ILL came about partly because "the German and the French governments were looking for ways of showing their good will through collaboration." (Pestre, 1997). Although it was not established until well after the War (1967), its origins can be traced to the same post-war reconstruction ambitions that led to the formation of the EC. ILL was later joined by the UK, and the European Synchrotron Radiation Facility (ESRF) was added to the site, providing a source of X-rays. Expansion brought in nine additional European countries as members, and the combined ILL/ESRF was firmly established as a European facility by 1989.

Again following on the successful CERN model, the European Space Agency (ESA) emerged as a European response to American strength in aerospace research; the European focus consolidating in part because of chronic difficulties in collaboration with the USA. For example, Krige, Russo and Sebesta (1997) point out that the foreign policy priorities of the USA towards the Soviet Union over Europe meant that the Apollo–Soyuz dockings took precedence over co-operation with Europe. While co-operation has proceeded with world-wide partners in the International Space Station, the European contribution is a distinct, modular component, reinforcing intra-European scientific co-operation.

In the 1960s, the demand for European scientific and technological co-operation outstripped the capacity of the EC to accommodate this from within its membership of six countries. In 1967, the EC Council of Ministers considered a proposal for European collaboration in seven S&T domains (EC, 1992), and decided to invite the participation of Austria, Denmark, Ireland, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom to join in the planning and development process.

By the time European Co-operation in Science and Technology (COST) was established as an intergovernmental organisation in 1971, Finland, Greece, Turkey and Yugoslavia had joined the other 15 countries; a secretariat within the European Commission provided support. COST has since expanded to 34 member states plus one co-operating

Successful initiatives, a developing sense of European identity and the impetus of American encouragement and US scientific competition, consolidated a European approach to research co-operation that was also to emerge in the techno-economic realm

country (Israel). It has spawned numerous follow-on collaborative research projects and both professional and research organisations such as the European Centre for Medium-Range Weather Forecasting based in the UK.

Like COST, the European Science Foundation (ESF) was established by the EC Council of Ministers, with the co-operation of the European Commission. Although it was first proposed by the French in 1958, it was not until 1974 that the ESF was created, with an initial membership of research councils from 15 European countries (Guzzetti, 1995). Now comprising 70 member organisations in 27 countries, the ESF supports a range of pan-European scientific and research activities, and provides a ‘voice’ for European science.

As the previous examples have shown, Western European scientific co-operation has had political as well as scientific origins, with the EC playing an important supporting role in many cases. A series of (mostly) successful initiatives, a developing sense of European identity and the impetus of both American encouragement and US scientific competition, helped to consolidate a European approach to research co-operation that was also to emerge in the techno-economic realm.

European technological co-operation

By the late 1960s, Europe was emerging from its post-war economic hardships, but across the Atlantic, in the USA, the economy was booming. A best-selling book, *The American Challenge* by Jean-Jacques Servan-Schreiber (1968), highlighted the technological challenge Europe faced from American competition and the “invasion” of Europe by American industry. This provided a powerful impetus for the development of European technological co-operation. Research on the “cost of non-Europe” led to another book, *The European Challenge* (Cecchini, 1988) as a response, published as the programme to complete the Single Market by the end of 1992 was in full swing.

The aerospace industry is an important example of European technological co-operation (Müller, 1990), initially through a set of projects started in the 1950s to develop and build combat aircraft, and spreading to the civil sector. Stimulated in part by competition with the US Government-supported COMSAT, the European Conference on Satellite Communications was established in July 1963.

Arianespace was an outgrowth of negotiation processes that had also led to ESA. It was created to produce and commercialise launch vehicles, and to attain European self-sufficiency. Airbus Industrie’s contributions to joint technological development within Europe is an additional example of how Europe reacted to US competition in aeronautics by pooling resources. “The history of Airbus is, at the same time, the history of European unification”, according to Christian Patermann (Krige and Guzzetti, 1997, page 320). Although criticised for being overly dominated by the French, Arianespace and Airbus have been considered a success in establishing viable European entities to rival US aerospace industry competition.

The unexpected announcement of the US Strategic Defense Initiative (SDI) in March 1983 provided the impetus behind the Eureka programme promoting industrially relevant, Europe-wide co-operative R&D. Convinced that SDI represented a form of support for civil industrial technology development despite having been presented as a defence programme, the proponents of Eureka were also caught up in the political momentum behind the establishment of the EC Framework Programme (Peterson, 1991).

If discomfiture in relations between Europe and the USA was the sparkplug, foreign policy considerations within Europe were the driving force behind Eureka. A complex set of circumstances in France and Germany and resonances with other diplomatic activities at the time, plus European Commission-instigated industrial and institutional reactions, combined to bring about the rapid establishment of Eureka as a European technological answer to the perceived American challenge.

Europe responded in other ways to the American challenge, supporting technological and economic measures to improve the competitive environment for European industry (Sharp and Shearman, 1987). The programme to complete the Single European Market by the end of 1992, which gave new momentum to European integration, was perceived in the USA as a ‘Fortress Europe’, which would raise barriers to American participation in European innovation activities. “1992” was, however, also viewed as a stimulus to performance of non-European countries in response to expected improvements in European competitiveness (Väyrynen, 1998).

Forces shaping technology and innovation policy can thus be regarded as reflecting complementary aspects of European (or national) internal policies and foreign policy considerations, including trade and economic competition. Within the EC, S&T co-operation and the completion of the Single European Market as a globally competitive entity acted together to advance the process of European integration.

Integration, cohesion, enlargement

The EC was active as a promoter of European scientific co-operation from the outset, but it was primarily in the economic and industrial realms at the heart of the EC's responsibilities that defined its support for research and technological development (RTD). The first Framework Programme (1984–1987) was agreed by the Council of Ministers on 25 July 1983 (OJ C 208, 4.8.83, page 1). With the Single European Act of 1987, the aim of RTD co-operation was laid out: "to strengthen the scientific and technological basis of European industry and to encourage it to become more competitive at international level."

As the EC's main vehicle for intra-European S&T co-operation, the Framework Programme is intimately bound up in broader processes of European integration. At its most basic, the requirement for transnational co-operation is an expression of internal European foreign policy. Like the EC itself, the Framework Programme is based on pooling capacity and incorporates an implicit (and occasionally explicit) commitment both to building cohesion within Europe and to integrating the accession countries.

The Framework Programme embodies a set of instruments designed to promote intra-European co-operative knowledge generation and diffusion through RTD projects, the creation of networks, shared facilities and researcher mobility. Specific support mechanisms include: shared-cost funding for transnational R&D; "concerted actions" whereby the costs of co-ordination are covered but research teams rely on national and private sponsorship; fellowships and other mobility schemes for scientists and engineers; the Joint Research Centre; demonstration projects; policy studies; and other accompanying measures such as European conferences and prizes.

Collectively, these instruments reinforce the scientific, human, educational, economic, regulatory and related dimensions of integration, in conjunction with the promotion of industrial competitiveness. Discussions on European co-operation in R&D have even served to influence the Community's own development, most notably in the course of negotiations over the Maastricht Treaty.[7]

The growth of European research organisations, networks and programmes and the growing number of students, researchers and institutions that participate in European research have had an important, sometimes even transformative, influence on research within the EC Member States.[8] Inter-organisational co-operation has reinforced an emerging European scientific identity, for example between CERN and ESO in the 1970s, ongoing collaboration between ESRF and EMBL, and the co-operation between the EC Framework Programme and COST, ESA and Eureka. Superimposed upon a diverse set of national scientific and cultural traditions, a distinctly European 'style' of research has been emerging, which embodies European norms of collaborative research.

Cohesion is another feature of S&T co-operation policy in the EC. Some mobility schemes provide support to researchers from less advantaged (mostly peripheral) regions of Europe upon their return to their home country. The EC Structural and Cohesion Funds have also been applied to S&T co-operation, for example through supporting the Greek Foundation for Research and Technology, and contributing to the GranTeCan telescope in the Canary Islands.

Enlargement is a third feature of intra-European S&T co-operation policy. Candidate countries, as part of their association agreements with the EU, become eligible to participate in the Framework Programme with Community funding. In the Fifth Framework Programme, it became possible for a candidate country's organisation to be part of a proposing consortium as if it were already within the EU.

Many scientific organisations that first emerged in Western Europe later extended co-operation and membership to Eastern Europe. CERN's growth in membership was not seemingly done so much for scientific or financial reasons but from an implicit commitment to expanding the geographical scope of European scientific co-operation. EMBO also extended to Eastern Europe, initially through individual fellowships and later by expanding membership to Eastern European countries. ESF and other European research organisations have similarly been expanding their membership eastwards.

Table 1 shows some examples of European S&T organisations together with their member countries.

In the 1990s, Western European co-operation with Eastern Europe developed rapidly, with scientific organisations and individual scientists themselves often taking the lead. It was the disintegration of the Iron Curtain and political/cultural interest in re-establishing European linkages that provided the context for this largely bottom-up East–West scientific integration process.

COST, which has remained closely associated with the EC, was especially well placed to reinforce the East/West aspect of European integration, as its original members included countries from both sides of the post-war divide and welcomed Central and Eastern European members from 1991. It has been viewed as particularly valuable in facilitating the integration of candidate countries' scientific communities into the EC through its close links with the Commission and the Framework Programme. Speaking at a COST Interaction Conference in Basel in 1995, Ruth Dreifuss, representing the Swiss Government, credited COST with having pioneered European integration and acting as an instrument of the enlargement of Europe, especially to Central and Eastern European countries (EC, 1996, page 8).

Other vehicles for EC enlargement utilised S&T co-operation. Initially an economic assistance programme, established in 1990, PHARE (Poland/Hungary[9] Aid for Economic Restructuring) was

Table 1. European S&T organisations: date established and membership

Organisation (year)	European Union Member States															EU candidate states, other European states and Israel																
	At	**Be**	**Dk**	**Fin**	**Fr**	**Ge**	**Gr**	**Ire**	**It**	**Lu**	**Nl**	**Po**	**Sp**	**Sw**	**UK**	**Bu**	**CH**	**Cy**	**Cz**	**Est**	**Hu**	**Ice**	**Isr**	**Lat**	**Lit**	**Ma**	**No**	**Pl**	**Ro**	**Slk**	**Slo**	**Tu**
CERN (1953)	L	O	O	L	O	O	O		O		O	L	L	O	O	L	O		L		L		A				O	L		L		A
JRC (1959)	L	O	L	L	O	O	L	L	O	O	O	L	L	L	L																	
ESO (1962)		O	L		O	O			L		O	L		O	L		L															
EMBO (1964)	O	L	O	L	O	O	O	L	O		O	L	O	O	O		O	A	L		L	L	O				O	L			L	L
ILL (1967)	L				O	O			L				L		L		L		L													
COST (1971)	O	O	O	L	O	O	L	O	O	O	O	O	O	O	O	L	O	L	L	L	L	L	A	L	L	L	O	L	L	L	O*	L
ECMWF (1973)	L	O	O	L	O	O	L	O	O	O	O	L	L	L	O		O		A		A	A					O				A	L
EMBL (1974)	O	O	O	O	O	O	O		O		O	O	O	O	O		O						O				O					
ESF (1974)	O	O	O	O	O	O	O	O	O	L	O	L	O	O	O	L	O	L	L	L	L	L					O	L		L	L	L
ESA (1975)	L	O	O	L	O	O		O	O		O	L	O	O	O		O										L					
Eureka (1985)	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	A	O	L	L	L	L	L	L	L	L		O	L	L	L	L	O
ESRF (1989)	A	O	O	O	O	O			O		O	A	O	O	O		O		A		A		A				O					

Notes: O = full member, original; L = full member, joined at later date; A = associated affiliated member or observer state; O* = Slovenia was part of Yugoslavia, which was an original member of COST

At = Austria, Be = Belgium, Dk = Denmark, Fin = Finland, Fr = France, Ge = Germany, Gr = Greece, Ire = Ireland, It = Italy, Lu = Luxembourg, Nl = Netherlands, Po = Portugal, Sp = Spain, Sw = Sweden, UK = United Kingdom

Bu = Bulgaria, CH = Switzerland, Cy = Cyprus, Cz = Czech Republic, Est = Estonia, Hu = Hungary, Ice = Iceland, Isr = Israel, Lat = Latvia, Lit = Lithuania, Ma = Malta, No = Norway, Pl = Poland, Ro = Romania, Slk = Slovakia, Slo = Slovenia, Tu = Turkey.

CERN = European Organisation for Nuclear Research, JRC = Joint Research Centre, ESO = European Southern Observatory, EMBO = European Molecular Biology Organisation, ILL = Institute Laue-Langevin, COST = European Cooperation in S&T, ECMWF = European Centre for Medium-range Weather Forecasting, EMBL = European Molecular Biology Laboratory, ESF = European Science Foundation, ESA = European Space Agency, ESRF = European Synchrotron Radiation Facility supplemented by S&T co-operation projects the following year, allowing researchers from the Central and Eastern European countries to collaborate with EC colleagues through a number of specific schemes. Technologies for improving nuclear safety and energy conservation formed an important part of PHARE. The PECO-COPERNICUS programme was launched in 1992 to support the integration of Central and Eastern European countries, specifically through support for conferences, networks, participation in certain Third Framework Programmes and COST actions.

From a policy perspective, the most striking thing about how S&T supports the European integration agenda is the extent and diversity of co-operation programmes, mechanisms, organisations and support schemes in place. It is then possible to discern patterns, common features and increasing coherence in how European S&T co-operation is organised and implemented.

As this section has shown, first scientific and then technological co-operation in Europe was influenced by more general ambitions that emerged in the post-war period and matured in response to external competition. European S&T co-operation was aligned with scientific, political, economic and cultural dimensions of integration, with the underlying aim of competing with the USA (and later Japan and other technologically advanced countries).

S&T co-operation was also used in support of integration through enlarging the EC/EU. The ERA (EC, 2000) is driving forward the integration process with new instruments designed to achieve greater co-ordination of research, while taking into account the EU's preparations for further enlargement. European S&T co-operation has thus been an implicit and often unofficial, but nevertheless real, expression of 'internal' European foreign policy priorities, including enlargement, that went beyond the pragmatism of proximity or purely scientific/ technological considerations.

S&T co-operation and global interaction

The Maastricht Treaty introduced two new elements relevant to European science, technology and foreign policy with respect to the rest of the world. Firstly, the aims of EC research were extended beyond supporting industrial competitiveness to incorporate all other policy objectives of the Community, including support for relations with third countries.

Secondly, as outlined previously, the Common Foreign and Security Policy 'pillar' was created. However, research and technological development policy, falling within the realm of the EC's institutions and activities, was and remains separate from the intergovermental CFSP. The lack of formal policy linkages between the two has meant that the relationships between EC S&T co-operation policy and at least some aspects of foreign policy are indirect if they exist at all. Nevertheless, European policies and practices towards S&T co-operation with third countries are a significant component of European relations with the rest of the world.

S&T co-operation has served to develop EC relations with non-candidate neighbouring countries such as Norway, Iceland and Switzerland, and countries in the Mediterranean region; this type of co-operation is expected to intensify.[10] S&T co-operation with the developing world has been associated with a complex array of aid, economic and infrastructure development packages as well as directed at specific problems in areas such as agriculture and public health.

An extensive set of intergovernmental agreements, mainly bilateral, has provided the EC, European countries and European organisations with opportunities to co-operate, but this is only one small part of the story. To a large extent, co-operation has been organised in 'bottom-up' fashion by economics, science and education ministries, other national government bodies and regional authorities, and by companies, European research facilities, independent laboratories, universities and individual researchers. International S&T co-operation has developed largely independently of formal foreign policy objectives or foreign ministries.

There are few opportunities for multilateral S&T co-operation with non-European countries apart from the largest-scale 'megascience' projects, some of which are discussed below. By far the most common mode of co-operation is through bilateral exchanges, collaborative projects and programmes, and technology transfer and training exercises.

Non-European countries and organisations

To provide a basis for developing concerted European policies on international co-operation, a major study was undertaken of the policies of the 15 EU Member States and three European Economic Area (EEA) countries towards S&T co-operation with various geographical regions and international bodies. This INCOPOL (International Co-operation Policy) exercise reviewed major policies and programmes of the European countries, covering the structures and modalities of co-operation, the public

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funds available, and major policies, trends and future prospects (Rhode and Stein, 1999).

The INCOPOL study found that (very) approximately 750 Mecu was spent by the 18 European countries on international co-operation with non-European countries and international organisations in 1996, roughly six times the expenditure at European-level. The regional distribution was approximately:

- 20% multilateral (mainly regional, for developing countries)
- 25% for co-operation with Africa
- 10% each for Mediterranean countries, Latin America, Asia and the former Soviet Union
- 12% for Central and Eastern Europe
- 2% for Arab countries and island states

INCOPOL was the first comprehensive survey of S&T co-operation with non-European countries at national level and at European level. The exercise encountered severe difficulties in collation and disaggregation of data, and in making international comparisons. Nevertheless, it was possible to observe some common features and characteristics of the national co-operation policies of the 18 European countries.

For example, there was considerable stability in existing policies, but also a great deal of fragmentation and isolated initiative. Historical and cultural links were typically more important than trade relations. There were indications that bilateral agreements and active ‘science diplomacy’ facilitate bottom-up co-operation, and that, where bottom-up links and private sector co-operation are strong, there is less public funding.

The INCOPOL study also highlighted some evolutionary trends, particularly with respect to the diversification of actors in Eastern Europe and in patterns of East–West European co-operation. Bilateral mobility schemes between EU/EEA and other countries were the most common, with some trends towards co-operative research, especially in France, the UK, the Netherlands and the Nordic countries.

Policies towards S&T co-operation reviewed by the INCOPOL study tended to reflect EU/EEA national research structures and priorities, rather than the needs of the non-European partner countries. Overall, the picture is exceedingly complex, with a vast and varied assemblage of co-operation arrangements, at all institutional and governmental levels, to say nothing of the individual research collaborations and the technological globalisation activities in the private sector (Archibugi and Michie, 1997).

International co-operation policy

European Community S&T co-operation with third countries has developed mainly within the Framework Programme, on the basis of case-by-case international agreements or policies giving access to specific programmes. From a policy perspective, the INCO programme adopted by the EC Council of Ministers on 23 November 1994 represented a significant step forward in the articulation and organisation of EC-level S&T co-operation with third countries (EC, 1997) as a form of S&T-based external relations policy. The areas covered by INCO in the Fourth Framework Programme were divided as follows:

- international S&T organisations and institutions;
- Central and Eastern European countries and the former Soviet Union;
- non-European industrialised countries; and
- developing countries.

The first area of INCO largely focused on other European S&T organisations and institutions, including COST and Eureka. In the second area, the TACIS (Technical Assistance to the Commonwealth of Independent States, plus Georgia and Azerbaijan) programme providing technical assistance to the former Soviet Union, was based on European experience of PHARE, although in the case of TACIS co-operation was not linked to EU enlargement policy.

INTAS (International Association for the Promotion of Co-operation with the Scientists of the Newly Independent States (former Soviet Union)) has supported nearly a thousand research projects selected competitively and for their relevance to the interests of both the EU and the partner countries. INCO also included support for co-operation with industrialised countries in recognition that S&T interaction and access to complementary knowledge would benefit European technological capacity. Co-operation with developing countries consolidated three different approaches that had been adopted in earlier Framework Programmes.

Intra-European S&T co-operation can paradoxically also stimulate co-operation between Europe and third countries, for example between British and non-European researchers and teams (Stein *et al*, 1993). One reason for this was that UK researchers were encouraged to collaborate internationally, without geographical constraints, following generally positive experiences of Framework Programme research; another was that the critical mass achieved through European collaboration made it easier to work with large teams elsewhere in the world, especially in the USA.

In the Sixth Framework Programme, international co-operation is no longer a separate category but is subsumed into mainstream European research and technological development. Of the €17.5 billion proposed by the EC Research Council in December 2001 for the Sixth Framework Programme, €600 million was earmarked for international co-operation.

The current set of arrangements for international

Any country or international organisation may participate in Framework project consortia and receive EC funding if this is in conformance with Community objectives and its participation can be justified as essential to achieving those objectives

S&T co-operation through the Framework Programme is complex and continually evolving. There are two main categories of non-EC countries: associated states, who may participate with Community funding; and third states and international organisations, who may participate under certain conditions, usually on a self-financing basis. Specific rules and conditions apply to sub-categories, for example, to those countries in the Euro-Mediterranean partnership.

The international co-operation regime is unusually liberal, in that any country or international organisation may not only participate in Framework project consortia but also receive EC funding if its inclusion is in conformance with Community objectives and if its participation can be justified as essential to achieving those objectives. Similar rules apply for co-operation under Euratom.

COST supports "concerted actions" by providing small amounts of funding for self-funded researchers to co-operate and conduct joint workshops and publication projects. As such, it is well suited to the inclusion of self-financing partners from non-member countries. There are currently 33 non-European institutions from nine countries participating in COST actions, plus another three participating non-governmental organisations;[12] Israel participates as a 'co-operating state' according to a set of specific rules. Although each such arrangement must be approved by the intergovernmental Committee of Senior Officials, COST has proven to be an open and flexible instrument for co-operation with non-European countries.

EC policy development for S&T has to complement other activities by virtue of the "subsidiarity principle". The complexities of stock-taking from the INCOPOL study, whose results became available in 1999, when combined with a renewed commitment to intra-Community integration and enlargement, led initially to a distinctly Eurocentric approach to S&T policy. Indeed, the ERA document (EC, 2000), which forms the main policy framework for taking forward European R&D through greater intra-European co-ordination, makes scant reference to the global context of science, technology and innovation.

However, in a Communication on "The international dimension of the European Research Area" (EC, 2001b), the European Commission presented the case for opening the ERA to the rest of the world. The emphasis on accession countries and those of the European Economic Area makes explicit reference to the political as well as the scientific and technological benefits. In making the case for a proactive policy on global interaction, the document also lays out the importance of access to world-wide knowledge, human and other research resources, and of co-operating in S&T to solve common problems.

In reviewing numerous examples of prior co-operation with third countries in areas such as agriculture, health and nuclear safety, and the global geographical range of co-operation partnerships, the Commission establishes a track record of EC-level co-operation. The document also indicates that, like the S&T co-operation policies of the 18 INCOPOL countries, European-level policy development has also had a fragmented and episodic character, reflecting bottom-up responses to various issues rather than centrally developed scientific or political strategy.

Big/mega/global science: Europe and beyond

It is not unusual for European organisations to co-operate with non-European contributors (for instance, in the case of the Large Hadron Collider at CERN), non-European members (for instance, Israel in EMBO) and global programmes (for instance, ESA and the International Space Station). Unlike the other European scientific organisations, ESO's major facilities are sited far outside Europe, in the mountains of Chile. An accord between ESO and the Chilean Minister for Foreign Affairs was signed in 1995, providing a framework for co-operation with Chilean astronomers.

The ISIS spallation neutron source in the UK might have become a European organisation but, following much consideration in the light of ILL/ESRF's facilities, ended up having Australia, India, Japan, Russia and the USA as members in addition to its eight European members. Less formal scientific co-operation exists as well, especially when it comes to the highly internationalised large facilities, anywhere in the world.

European countries, and increasingly the EC as an entity, participate in global-scale S&T co-operation, including 'megascience' projects and multilateral programmes. Examples of the former include the International Space Station, the Ocean Drilling Programme and the International Thermonuclear Experimental Reactor. Multilateral co-operation includes the Human Frontier Science Program (HFSP), the Intelligent Manufacturing Systems (IMS) programme, the Human Genome Project (HGP) and scientific support for the Intergovernmental Panel on Climate Change (IPCC). Each of these is an exceptional arrangement, and each is bound up with foreign policy dynamics.

HFSP and IMS were both initiated by the Japanese Government in the wake of trade disputes in the 1980s; Japan also opened its Real World Computing Partnership to partners in Europe and the Far East in 1992. HFSP has its headquarters in Europe (Strasbourg); the transformation of IMS from a Japanese-led to a multilateral, global programme was brought about through the initiative of the European Commission in co-operation with the USA and other countries.

The internationalisation of the HGP (Cook-Deegan, 1994), most significantly with the entry of the UK-based Wellcome Trust, influenced the way in which the global co-operative project was organised and conducted. Although HGP was not initiated or managed by national governments, policymakers at the highest level took an interest in the project and its scientific outcome. The Clinton/Blair satellite linkup on 26 June 2000 trumpeted the scientific achievement that was, in effect, a predominantly US/UK collaboration (80–90% of the sequencing being done in these two countries).

IPCC had a political mandate for scientific input on specific questions related to the development of policies for managing climate change. Although there is no formal process for co-ordinating research policy, the importance and prominence of the IPCC make it highly influential in setting scientific priorities worldwide, including in Europe.

This section has provided a brief overview of the extent and variety of European S&T co-operation with non-European countries; collectively these constitute an important component of European foreign relations. For the most part, however, co-operation with third countries has been bottom-up and S&T policy-led, foreign policy providing an unofficial context rather than a specific strategy. This includes, for example, the extension of European S&T co-operation to non-European countries and organisations through COST, the Framework Programme, and international scientific organisations.

We now turn to the ways in which European experience in S&T co-operation and S&T-related aspects of foreign policy might inform the development of broader types of international co-operation.

Foreign policy and global S&T co-operation

Globalisation processes — scientific, technological, economic, cultural — and the emergence of global issues — sustainable development, climate change, infectious diseases, trade — have begun to stimulate demand for greater co-ordination between S&T and foreign policy from various quarters. In the USA, for example, the scientific community raised these issues in the 1990s, leading to the publication of an influential report by the National Research Council (1999) and a greater profile for science within the State Department.

In the United Kingdom, a Science and Technology Unit was established within the Foreign and Commonwealth Office in 2001, to co-ordinate the work of a larger complement of science diplomats to be based in 22 countries. The European Commission sponsored a study on the inter-relationships between international co-operation in S&T and foreign policy in Europe, the USA and Japan to inform the development of its external relations policies (Stein, 1999).

The planned enlargement of the EU has posed considerable practical challenges for the next phase of European integration. Although the Treaty of Nice (2001) imposed limits on the numbers of European Commissioners and Parliamentarians, the challenges of implementation in a system with almost twice the number of Member States are formidable. It is exceedingly unlikely that the EU will anytime in the near future seek further formal expansion beyond the ten countries already planning to join in 2004 and the three additional candidate countries. For now, the EC/EU will continue to use existing diplomatic tools such as association agreements with non-European countries.

The complex relationships between science, technology and foreign policy are discussed in the "Introduction" to this special issue. When the different types of actor in Europe and their interrelationships (or segregation) are taken into account, the picture is far more subtle and complex. In the "International dimension of the ERA" document (EC, 2001b), the lack of co-ordination amongst the European countries is highlighted.

Most significantly, from the perspective of this paper, the "International dimension…" Communication explicitly recommends that strategy should focus on "developing scientific and technical activities useful to the implementation of EU foreign policy" and "enlisting the scientific and technological resources of the EU and of third countries" to respond jointly to world problems such as food safety, environmental protection, health, and diseases associated with poverty. European foreign policy objectives are outlined for which S&T co-operation with different world regions and EU co-operation partners would be appropriate:

- Mediterranean and Balkan countries: in addition to economic co-operation, the promotion of co-development for greater "stability, prosperity and security", implying a need for technology transfer, and co-operation on "integrated management of water, agriculture and the agro-food industry, health and environmental protection, seismology, energy and transport, preservation of the cultural heritage, the digital divide".
- Russia and the Newly Independent States: the priorities here are to stabilise the research capacities of these countries, with particular attention to conversion of defence research to civil

applications, and co-operation on problems such as "non-proliferation, health and environmental safety related to industrial change, including nuclear safety and energy issues".

- Developing countries: sustainable development and socio-economic welfare are the priorities, which includes sustainable management of natural resources, health, food and economic development, including efforts to combat poverty, and preservation of cultural heritage.
- Emerging economies and industrialised countries: recognising that many emerging economies, such as China, India, Argentina, Chile, Mexico and South Africa have considerable research capabilities, the emphasis in this category is on reciprocal access to knowledge and skills, and on identifying specific areas where distributed research on common priorities would achieve efficiencies and mutual benefits.
- International organisations: recognising the roles already played by organisations such as the OECD (and the Global Science Forum in particular), the World Health Organisation and various United Nations bodies (such as the Food and Agriculture Organisation and UN Environmental Programme), the priority is for the EU to raise its profile in activities addressing global problems such as food safety, sustainable development, infectious diseases, and science and society issues.

The communication from the European Commission signals that a more strategic approach to science, technology and foreign policy may be starting to emerge in the EU. This in turn raises the question of what European experience, institutions and instruments could contribute to realising a more strategic, systematic approach to S&T-related co-operation at global level.

Certainly, the experience gained through European approaches to combining the intra-European, integration objectives with problem-oriented priorities in the Framework Programme and other, complementary approaches, could provide potentially useful models for more widespread co-operation. The main features of this European approach are:

- subsidiarity, which stipulates that European co-operation should complement and augment S&T activities already undertaken by the Member States, regions, companies and other institutional actors, and, with the ERA, an increasing emphasis on intra-European co-ordination;
- pooling capacity, collegial decisionmaking and the distribution of research responsibility based on mutual respect and the appreciation of diversity;
- the successful management of combined political and scientific objectives through a set of eligibility requirements plus peer review to assure the validity and quality of European research projects as well as their European relevance;
- recognising how competition and collaboration can, if properly managed, be mutually beneficial (model contract for IPR (intellectual property rights), complementarity);
- flexibility and continuity: the use of multiannual budgets, as for the Framework Programme, protects against the possible capriciousness of annual budget rounds, while providing opportunities to revise existing S&T priorities or to introduce new ones;
- the use of various types of instrument in combination for supporting research and innovation, ranging from researcher mobility schemes to concerted actions, networks, collaborative research projects, plus the deployment of other types of funds (structural, cohesion and technical assistance) to support international co-operation in S&T;
- openness to collaboration from non-member countries anywhere in the world according to a set of transparent rules and requirements;
- recognising the ways in which international S&T co-operation (foreign relations) may be aligned with foreign policy.

The distinctly European 'style' of research is influenced by the formalities, customs and ethos of EC/EU co-operation more generally, as well as by experience of collaboration in the many other European S&T programmes, networks and organisations. European-style S&T co-operation is a learned skill, as well as being a manifestation of shared historical and cultural experience that is not necessarily applicable or natural to people in other parts of the world.

Global co-operation will necessarily have to accommodate the far more diverse set of ideas and cultures present around the world. Nevertheless, European approaches to co-operation may provide practical, tried and tested models that can contribute to the design of future global-scale policies and programmes. For example, the IPR regime for the IMS programme was based on European experience of using model contracts under the Third Framework Programme (Parker, 1998).

There are few global-scale institutions that can

Global co-operation will have to accommodate the diverse set of ideas and cultures in the world; European approaches to co-operation may provide practical, tried and tested models that can contribute to the design of future global-scale policies and programmes

provide a basis for organising multilateral co-operation in S&T. United Nations organisations such as FAO, UNEP and UNESCO (Educational, Scientific and Cultural Organisation), and the OECD Global Science Forum, provide valuable loci for stimulating co-operation, exchanging information and supporting co-operation. However, these bodies are limited in terms of scientific/technological fields, budgets, or face other types of constraint in implementing their own projects. There is no global Framework Programme, nor a global COST, nor any such programme or organisation large and flexible enough to accommodate the diverse and rapidly changing world of science and technology. Yet it is now hard to imagine any domain of scientific or technological research that would not benefit from opportunities for international collaboration without geographical restriction.

The EC has only limited instruments with which to conclude international agreements, which in common with most other countries and institutions are dominated by bilateral and case-by-case arrangements. European scientific organisations, European industry and publicly supported programmes, including the Framework Programme, can be used to extend co-operation world-wide, although this would inevitably be along European terms.

The extent of global interaction is beginning to render this piecemeal approach to policy development inadequate. The impacts of globalisation now permeate the world in economic, environmental and social spheres, creating new patterns of work, socio-economic development and everyday life (Castells, 2000). Problems of sustainable industrial development, the alleviation of poverty, environmental protection, the regulation of trade and interactions based on ICT (information and communication technology), the construction of better mutual socio-cultural understanding and the science/technology/society interface have become global issues, requiring concerted, global solutions. In the White Paper on European Governance (EC, 2001a), the Commission writes:

> "The Union should take the global dimension into account in assessing the impact of policies, in establishing guidelines for the use of expertise, and through a more pro-active approach to international networks … By acknowledging the global dimension more strongly, the Union will strengthen its voice in multilateral negotiations … International action should be complemented by new tools …"

Intra-European experience of multilateral, multilingual, multicultural co-operation through a great variety of mechanisms, could contribute significantly to the design of global S&T co-operation systems, although innovations in policy design will be necessary to bring this about in a truly significant manner at global level. At the same time, S&T advisory systems that effectively support the negotiation of international agreements are not yet in place, although here again EC experience, and lessons from the IPCC, could prove valuable. The main challenge, for science, technology and foreign policy to work in concert, remains to be addressed.

Conclusion

Intra-European co-operation has become a significant feature of the European science and technology landscape and is progressing to the co-ordination phase with the implementation of the European Research Area. S&T co-operation in Europe was shaped by the combined forces of scientific, political, economic and cultural integration following World War II. Competition with the USA, and later Japan and other technologically advanced countries, served to reinforce the construction of European S&T co-operation, which in turn led to a European style of international co-operation. As the EC/EU has grown, S&T co-operation has been used to support the 'widening' side of the integration coin through transition arrangements for accession countries.

European integration processes, including S&T-related network and institution building, have taken place alongside tremendous growth in world trade and other forms of globalisation over the past half century. The emergence and development of European S&T co-operation has been situated within a more global context, exhibiting both competitive and co-operative elements with respect to Europe's interactions with the rest of the world. Through a progressive and organic process, if uncoordinated, S&T co-operation with third countries has come to constitute a major component of European foreign relations in the Member States and for the EU as a whole.

At global level, the emergence of scientific rationales and issues appropriate to co-operative R&D, along with the facilitating advances of information and communication technologies, have not so far been matched by political aspirations for integration that have characterised the post-War European experience. Apart from the writings of science fiction, there is no extra-terrestrial competition to act as a stimulus to global integration.

Yet, as the world shrinks and global interactions become increasingly important determinants of the economic, social and political conditions in countries and regions around the world, simple pragmatism would imply a need for greater co-operation on a global scale. The penetration of ICTs into the technoscientific world has helped to make global co-operation in science and technology, in all fields, and in terms of advice to policy makers, a realistic prospect.

Global co-operation in science and technology, to improve knowledge production, to address global issues and to build solidarity world-wide, would appear not only to be feasible in the 21st century but there are certain similarities to the post-War conditions that led to European scientific and technological co-operation. In 1951, the European Coal and Steel Community Treaty resolved:

> "to create, by establishing an economic community, the basis for a broader and deeper community among peoples long divided by bloody conflicts; and to lay the foundations for institutions which will give direction to a destiny henceforward shared."

Post-September 11, a more comprehensive approach to global co-operation could lead to the sorts of the benefits that Europe has itself experienced over the past half century. Stirrings of interest from both international S&T policy and foreign policy quarters have begun to place scientific and technological aspects of global co-operation on the map. It will take a concerted effort but by combining diplomatic efforts with those of the S&T policy community, science, technology and foreign policy can be mutually reinforcing in the quest for a better global future.

Notes

1. Following the European Council in Brussels on 24–25 October 2002, ten countries are expected to join the EC/EU in 2004: Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, the Slovak Republic and Slovenia (EC, 2002), with three additional countries (Bulgaria, Romania and Turkey) having applied to join.
2. CFSP is an outgrowth of the earlier policy of European Political Co-operation (EPC) established by the EC with the Davignon Report of 1970. EPC was originally set up to provide an intergovernmental framework for co-operation amongst the foreign ministries of the Member States, while CFSP provides a framework for EU foreign policy.
3. S&T co-operation was enshrined within the EC's remit from the very outset. Article 55 of the European Coal and Steel Treaty of 1951 provided for technical, economic and social research related to the coal and steel industries, while Article 4 of the Euratom Treaty of 1957 dealt with co-operation in nuclear energy. Although in formal terms, the European Economic Community Treaty (also signed in 1957) only linked research to improving agricultural productivity, co-operation in S&T was implemented under the general-purpose Article 235.
4. The Troika is comprised of representatives of the current Presidency of the EU along with the immediate predecessor and successor Presidencies. Troika delegations represent the EU under certain diplomatic circumstances.
5. Up-to-date information can be found at <http://www.europa.eu.int/comm/external_relations/delegations/>, last accessed November 2002.
6. Because the status of international agreements with associated states and third states is constantly changing, the reader is advised to consult <http://www.cordis.lu/fp5/> (last accessed 1 November 2002) and to follow links to "participation rules" for up-to-date information.
7. See, for example, articles in the press such as "Confusion over Community's powers on research", *New Scientist*, 21/28 December 1991.
8. See, for example, Georghiou *et al* (1993), which is one of a series of national impact studies produced for the European Commission.
9. Since extended to other Central and Eastern European countries.
10. The Euro-Mediterranean Partnership was launched in November 1995. The preliminary draft constitutional treaty being prepared by the European Convention identifies "privileged" relations with neighbouring countries as a priority.
11. Up-to-date information is available on <http://cost.cordis.lu>, last accessed 1 November 2002.

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