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# **China-Europe Relations in Science and Technology**

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## **China's Emerging Technological Trajectory in the 21<sup>st</sup> Century**

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## Summary<sup>1</sup>

The European Commission on March 1 2002 approved the Country Strategy Paper<sup>2</sup> (CSP) for China, which set out the framework for EU co-operation with China during the period 2002-2006. The co-operation strategy outlined in the CSP is designed to support the implementation of the EU's broad policy objectives regarding China. These include further integrating China into the world economy and world trading system; supporting China's transition to an open society based on rule of law and respect for human rights; making better use for European resources by improving co-ordination between EU assistance and bilateral spending by Member States; and raising the EU's profile in China.

An indicate budget of €250 million is planned for the period 2002-2006 to support EU programmes in China. The Country Strategy Paper will provide the instrument for guiding, monitoring and reviewing EU assistance.

The cooperation in science and technology between China and Europe started in 1981<sup>3</sup>, actually trailing the Sino-US Agreement on S&T cooperation that was signed by Deng Xiaobing and then President Carter in 1979. The Ministry of Science and Technology (MOST) in a newsletter mentions a number of important fields in its European collaboration such as telecommunication, energy, biology, aeronautics and space, with the China-German Joint Laboratory on Molecular Medical Sciences that was established in 1998 and early collaboration with Italy on cosmic ray detection. The cooperative research program between China and France has led to the establishment of three China-France cooperative research institutes in the fields of information, automation and applied mathematics. In addition to collaboration between China and European nations there are also a number of projects that involve EU as such and examples include Global Digital Telecommunication, Digital Audio Broadcasting and Biomass Energy.<sup>4</sup>

A S&T cooperation agreement that was agreed upon in December 1998 set the stage for a new development stage between China and EU, both in terms of research level and scope. Subsequently, the EU Fifth Framework Program for Science and Technology was made open to China (now followed by the Sixth Framework Program) and conversely China has offered participation in China's "basic studies and high tech research plan" to foreign research institutions and scientists.<sup>5</sup>

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<sup>1</sup> I greatly appreciate the assistance provided by Dr Jürgen Sanders and his staff at the Delegation of the European Commission in Beijing, having indicated sources of information and provided background documents for the preparation of this paper. In the final drafting of this paper I have benefited in a major way from information provided by Dr. Wenjie Qian at the Delegation in Beijing and Mr Jean-Yves Roger of the IST Programme in Brussels. Factual errors and misinterpretation of data and information remain solely my responsibility.

<sup>2</sup> Delegation of the European Commission, IP/02/349-Brussels, 1<sup>st</sup> March 2002 – China: European Commission Approves Country Strategy Paper 2002-2006

<sup>3</sup> Ma Songde (MOST Vice Minister), China's International S&T Cooperation: Importance and Promise, China Science and Technology Newsletter, No. 228 July 10, 2000

<sup>4</sup> *ibid.*

<sup>5</sup> *ibid.*

Chinese participants have been encouraged to join the Information Science and Technology (IST) program which require it should conform to EU interests, provide substantial added value in implementing science policy and involve the required participation of entities from EU and associated states. China is presently through its major universities participating in 11 IST projects with a total investment of €30 million of which the Chinese side has contributed €5 million. The indicated activities are an outflow of China's stated policy to have participation of overseas research institutions and scientists in the country's basic and high-technology programs.

Although, the direct funding and involvement of the European Commission is important in supporting and guiding China-Europe relations in science and technology the overwhelming contents will be include in the rapidly expanding trade between the two regions. Furthermore, direct contacts between scientists and researchers of a bilateral nature will also expand rapidly. China will over the next 10-20 years provide the rest of the world with extraordinary possibilities for commercial and intellectual exchange - on the assumption that China's experience in political smooth transformation and rapid economic development of the past two decades will continue. China as an emerging technological superpower will have far-reaching Consequences for Europe (EU) and the rest of the world

These possibilities will not fully materialise unless there exists a deep understanding of the process and initiatives are formulated to bring mutual benefits. The developments within science and technology briefly indicated in this paper present challenges to three different EU communities – the business community, the science and technology community and the political community.

In order to capture possibilities there is a need for deep knowledge of regional changes and understanding of the underlying factors. Without such recognition it will be difficult to be aware of ongoing processes and impossible to anticipate future trends and discontinuities. This requires a two-pronged approach of building competencies inside EU and establishing long-term relations with institutions in China. This paper offers a fragmentary view of the budding relationships that are emerging between China and Europe.

## **Introduction**

European Union presently consists of 15 countries which in size and S&T structures are very different. S&T relations exist in three major domains which are partly overlapping. First, the large and expanding trade between EU and China includes substantial amounts of high-technology products and associated technology transfer, which are in main channelled through private companies on commercial conditions. Second, universities and research organisations in individual EU countries are rapidly expanding their contacts and collaboration with counterparts in China. Third, the EU is through its commission and various agencies formulating and implementing policies to develop and expand S&T relations with China<sup>6</sup>. This paper attempts to cover all three domains, although fragmentary and with a focus on EU-level relations and trade between the two regions.

The official view is that EU itself is changing in ways that will lead China to adjust its own strategic vision of the European continent. On 1<sup>st</sup> of January 2002, the introduction of the Euro, it is argued, has had a profound impact on the Chinese leadership, business community and public opinion. The impending EU enlargement, the eventual building up EU defence and security capacities, the willingness of the EU to assert itself on the world stage through common foreign policy mechanisms are ingredients that has the potential of creating an increasing interests fro strengthening Chin-EU relations. This view is reflected in Chris Patten, European Commissioner for External Relations, making his first official visit to China in April 2002 at the invitation of the Chinese government.

The EU's strategy is laid out in a Communication with the title "Building a Comprehensive Partnership with China" that was approved by EU governments in June 1998.<sup>7</sup> In its assessment the following suggestions are made to support integrating China further in the world economy.

1. strengthening existing sectoral dialogues and agreements in key areas such as information society, environment, energy, and science and technology
2. develop new one in areas such as enterprise policy, industrial standards and certifications, maritime transport and competition policy

The Chinese national basic research programs are open to EU partners, as part of the EU-China S&T agreement and the EU delegation in Beijing emphasizes the 973 national basic research program, the 863 national high-tech research program, as well as the Natural Science Foundation of China as a potential partner.

The same assessment also stated that the ongoing consolidation of EU integration makes the Union better equipped to engage China on an increasingly wide range of issues. Furthermore there have also been significant developments in China which needs to be taken account of in

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<sup>6</sup> Components of the innovation system in Europe are normally managed at the country level. Though the EU assists through programs and funding, a primary objective lies in addressing integration of the Community's diverse membership, which will soon include another 10 countries, through integration across cultures, languages and regions. Thus, networking and efficiently using the strengths of its members are essential modes of operation.

<sup>7</sup> In June 2001, the Commission adopted a new Communication aimed at reporting on the implementation of the 1998 recommendations and brining policies forward – "EU Strategy Towards China: Implementation of the 1998 Communication and Future Steps for a more Effective EU Policy, COM (2001)265 final.

an emerging policy towards to China. This has become evident from China's increasingly assertive international role and growing political and economic weight. China is already the world's second largest trader, the second largest recipient of FDI, and a major player in certain key economic sectors such as telecommunications and the information society, and in energy. Action points include the alumni support for EU-cooperation programs, such as the EU-China Academic Network, the EU-China Junior managers program, and the EU-China Scholarship 2000 project.

EU has a matter of formal policy at early stage decided to adopt the transfer of technology to China as a matter of formal policy. The EU Commission in its long-term strategy states that "initiatives to promote economic and social reform should offer training and technical assistance to support modernization and market oriented policies in key economic sectors."<sup>8</sup> Furthermore, already in 1986 the European automotive and aerospace organisations signed a pact, as part of the EU-China Industrial Cooperation Program, for which both sides contribute financially to "assist in the harmonisation of technical standards, to assist industrial training in manufacturing as well as management".<sup>9</sup> It cannot be ascertained whether this agreement has contribute to the early dominance of European car makers in the Chinese market where the Volkswagen Group has maintained a dominant position for a number of years.

In addition the European Association of Aerospace Industries (AECMA) at the time also entered into a joint aerospace development program with the General Administration (CAAC), and the Aviation Industries of China (AVIC). The goal of this program is similar to that in the automobile sector of building closer ties and provides training. The Airbus Industry has contracted a number of parts for its various aircraft to be co-produced by Chinese JV partners.

However, China has been assembling aircraft and components for years. Both Boeing and Airbus, world leading makers of passenger aircraft, contract the manufacture of parts like tail fins, nose cones and aircraft doors to factories in China. Boeing was first to consign the production of aircraft doors to a company in Xian in 1982, and a Shanghai Factory in 1986 started assembling McDonnell-Douglas aircraft in 1985. More recently Empresa Brasileira de Aeronautica (Embraer) in Brazil produced its first Chinese-made 50-seater aircraft in Harbin in late 2003. Building on this proven capability China at the end of 2003 embarked on the ambitious aviation project to build a small aircraft for less than 100 passengers. The company, Avic-1 Commercial Aircraft Co. (ACAC), will rely on foreign suppliers for advanced aviation and aerospace technology. The booming Chinese markets has attracted General Electric for supplying the engines, Parker Hannifin for providing the fuel and hydraulic systems, Rockwell Collins will supply avionics and a Honeywell-Parker joint venture has preliminary agreed to provide primary flight control system.<sup>10</sup>

These efforts have given EU companies exposure in China and to counterparts in the country. In return PRC companies will not only receive advanced technologies in key industries, but will also receive training on how to utilise this technology, says a US report.<sup>11</sup> The European approach to the Chinese market is two-pronged with technology transfer being one of them.

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<sup>8</sup> "Commission Communication to the Council on a Long Term Policy for China-Europe Relations", European Commission Delegation to China, 1986

<sup>9</sup> "EU-China Industrial Cooperative Programme in the Automotive Sector", European Delegation to China, 1996

<sup>10</sup> Dolven, Ben & Neuman, Scott, China's Aviation Dream, Far Eastern Economic Review, December 25, 2003

<sup>11</sup> US Commercial Technology Transfers to the People's Republic of China, DFI International for the Bureau of Export Administration

The other is direct financial aid which has focused on human resource development, support to economic and social reform, business and industrial co-operation, protection of the environment and rural development. EU has an example provided substantial resources to the China Europe International Business School (CEIBS) in Shanghai<sup>12</sup>.

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<sup>12</sup> CEIBS was established on November 8, 1994 in Shanghai, now based on its own campus in Pudong, Shanghai, under an agreement between MOFTEC and the European Commission. CEIBS receives financial support from the Municipal Government of Shanghai and the European Union. Its joint venture partners are Shanghai Jiaotong University, and efmd, the European Foundation for Management Development, which provide the institutional guarantees that make the school a centre of excellence in business management education and research within Asia. CEIBS has become the leading China-based international business school. Its main objective is to contribute to the economic development of this country and its business communities. It does this by offering to MBA students, to managers and senior executives of companies operating in, or planning to enter China, the latest knowledge and a thorough understanding of current practices in international management, helping participants to adapt them successfully to their own business environment. . CEIBS also has offices in Beijing and Shenzhen.

## **Opportunities**

Science and technology ranks high among current and predictable up-and-coming opportunities for foreign partners in China. EU-China cooperation in Science and Technology started in the early 1980s, and has notably increased during the European Commission's 4th and 5th Framework Programme for Research and Technological Development (1994-2002). The main instrument has been the EU's programme for Scientific and Technological Cooperation with Developing Countries (INCO). More than 100 EU projects have included Chinese partners, and China has been most active cooperation partner amongst the non-member states.

After signing the EU-China S&T Agreement S&T agreement<sup>13</sup> in 2000, the Chinese Ministry of Science and Technology (MOST) started to actively support Chinese project partners. In 2001 the number of new projects increased to 33, which includes 19 new projects in INCO-DEV with a total budget of €17.1 million, and 14 new projects in the thematic programmes with a total budget of €22.3 million. Chinese researchers compete directly with Europeans researchers for projects. They are more and more successful, especially in the areas of IT, life sciences, energy and materials research. Their interest has further increased in the 6th Framework Programme that was formally announced in November 2002.

An EU-sponsored analysis<sup>14</sup> that main benefits for Europe includes: helping China address its development challenges, achieving political and economic goals and gaining access to China's large market. China will benefit from gaining access to advanced technologies, input from highly skilled scientists and researchers, financial support on projects with shared costs, and strengthened political ties. Furthermore EU and China are systematically exploring venues of international collaboration to advance their international competitiveness.

The report on the Chinese Innovation System suggests in its report that there exists four major areas of opportunities for the European Commission to develop stronger ties with China in field of science and technology to mutually support innovation:

1. cross-border science networks
2. common innovation indicators
3. cross-border experience in regional development
4. WTO standards training

### Cross-border Science Networks

The objective would be to develop a virtual-based China-European Science Network focused on fostering cross-borer innovation activities within the science and technology field. This would require identifying the current and relevant traditional networks in China and in EU, and to identify and develop mechanisms that would make interaction strong and meaningful. The expected results would be a self-sustaining virtual gateway to Chinese experts and infrastructures within the research priority areas of the EU. This would lead to ongoing long-

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<sup>13</sup> Agreement for scientific and technological development between the European Community and the Government of the People's Republic of China. This document spells out forms of cooperative activities, coordination and funding – with intellectual property rights covered in an annex.

<sup>14</sup> InnoChina: A Study on the Policies, Structures and Training Programmes, which have evolved to encourage innovation in the Science and Technology of the People's Republic of China, Sociedade Portuguesa de Inovacao – Consultadoria Emprserial e Fomento da Inovacao, Porto, 2002

term cross-border collaboration within the science and technology fields are influenced through the support of the EU research priorities.

#### Common Innovation Indicators

The objective would be to identify and implement common innovation indicators within China and Europe which would support policy development that would foster cross-border innovation activities within the science and technology field. The result would be a common approach to facilitate an improved mutual understanding of the innovation frameworks in Europe and China.

#### Cross-border Experience in Regional Development

There is a growing concern in China of a growing disparity in development between the rural and urban regions, and between coastal and Western regions. The objective would be to share recent regional development experiences in an effort to further develop innovative policies that will have the greatest positive impact in development regions of Europe and China. This would result in an opportunity for both Europe and China to benefit from each other's experience in promoting regional development through the use of science and technology.

#### WTO Standards Training

The accession to WTO and increasing involvement in global markets creates a demand for understanding new business practises, including attention to international standards and how to conform to such requirements. The objective would be to provide WTO standards within relevant science and technology sectors. This would result in the development of strong relationships to foster cross-border innovation activities while providing “the opportunity for the 6<sup>th</sup> Framework Programme to continue to gain exposure as a leading programme in areas of concern to the Chinese Science and Technology sectors”<sup>15</sup>.

European parties can expect strong support from the public sector when entering into collaborative projects that include S&T research and innovation activities in China. However, the parties involved should have a clear and reasonable understanding of financial commitments which many times are difficult to obtain in the absence of earlier experience. Thus, the creation of cross-border networks becomes important. However, considerable challenges remain in science and technology collaboration, given remaining uncertainty in changes in administrative policies as the long-term implications of globalisation are being displayed.

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<sup>15</sup> *ibid.*

## ***A Review of EU-China Collaboration in Science and Technology***

EU-China cooperation did not start until some ten years after the establishment of EU-China diplomatic relation in 1975. In 1983 the then Commission President, Mr Gaston Thorn, announced the inclusion of China in the list of countries benefiting from EC financial and technical aid, although on a modest scale. Naturally cooperation have been formulated in a number of legal documents of which some important ones include

1. EC-China commercial agreement, signed in April 1978
2. EC-China commercial and economic cooperation agreement, signed in May 1985
3. EC-China scientific and technical cooperation agreement, signed in 1999
4. EC-China maritime cooperation agreement, signed in December 2002
5. Agreement on the Galileo Navigation Cooperation, signed in October 2003, with an agreed contribution of €200 million from China
6. EU-China industrial policy dialogue, signed in October 2003
7. Agreement on research on peaceful use of nuclear energy, expected to be signed in 2004

The present EU-China cooperation portfolio includes 36 projects with an overall budget of €260 million. Of this total the environment sector projects represent one third (33.7%), followed by human resource development projects (26.7%), projects in favour of economic and social reform (18.5%), and projects in the field of rule of law and good governance (12.6%). EU strategy paper on China proposes three areas for priority action – Economic and social reform, Sustainable development, and Good governance. Considering China's human and geographic dimensions and the still short duration of EU-China cooperation it is still too early to assess consequences and implications for China. However, among success stories it may be justified to mention the China-Europe International Business School (CEIBS) project in Shanghai, although the initial stage of the project was not very successful, when originally established in Beijing. The transfer to Shanghai and its collaboration with the Shanghai Jiaotong University has made its later implementation successful, and CEIBS has only become well-known in China but also increasingly in other parts of the world.

A sense of an increasing mutual understanding and appreciation between China and EU is reflected in the almost simultaneous publication in October 2003 of policy papers in Brussels and Beijing. The EU policy paper has the sub-title "A maturing partnership – shared interests and challenges in EU-China relations".<sup>16</sup> This document directly relates to China Country Strategy Paper (CSP) covering the period 2002-2006, and the National Indicative Program (NIP) for 2002-2004, approved in February 2002 and indicating funding of up to €250 million.

The document focus is on political issues although economic development and relations are discussed. In this context it is revealed that economic and trade relations between the EU and China have developed in step with China's emergence on the global economic scene. The country in 2002 overtook Japan to become EU's second largest trading partner, outside Europe, with a trade volume of more than €115 billion. The EU is also a major investor in

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<sup>16</sup> Commission of the European Communities, Commission Policy Paper for Transmission to the Council and the European Parliament, A maturing partnership – shared interests and challenges in EU-China relations (Updating the European's Commission's Communications on EU-China relations of 1998 and 2001), Brussels October 9 2003, COM(2003)533

China with a stock of FDI at US\$34 billion by the end of 2002. However, EU maintains a substantial trade deficit with China which reached €47 billion in 2002.

Research cooperation has been increasingly important under the 1999 S&T agreement and following the creation of the joint EU-China S&T Cooperation Promotion Office in Beijing in mid-2001. Research projects involving China and launched since 2000 have a total budget of more than €94 million. The agreement to join the Galileo satellite system and the initial agreement to join the fusion energy program ITER – to be discussed further on – reflects closer relations in science and technology pursuits between EU and China.

Among new action points the document suggests an expansion in the cooperation under the 1999 EU-China Science and Technology Agreement making best use of new possibilities provided by the EU Sixth Framework Programme with special attention to biotechnology, and the “Digital Olympics” initiative for Beijing 2008. It is also suggested that a second high-level “China-Europe S&T and Innovation Policy Forum” should be held in Beijing during the second half of 2004. Towards the end the policy document discusses raising the EU’s profile in China and improving the mechanisms of the relationship.

In the response document<sup>17</sup> from China it is emphasized that “(T)here is no fundamental conflict of interest between China and EU and neither side poses a threat to the other. However, given their differences in historical background, cultural heritage, political system and economic development level, it is natural that the two sides have different views and even disagree on some issues”.

Further it is stated that: “China welcomes more EU development aid, especially in such fields as the environmental protection, poverty-alleviation, public health and hygiene and education. China also welcomes a stronger and more active role of the EU in human resources development, in particular, personnel training for China’s central and western regions and build-up of China’s capacity of participating in multilateral trading regime.”

On IT the document states: “The Chinese side would like to see EU participation in China’s IT promotion. The mechanism of the EU-China working group on information society will be strengthened. Exchanges and dialogues will be conducted on strategies, policies, rules and regulation of information society. Trade in IT products and industrial and technology cooperation will be actively boosted. Greater exchanges in intellectual property rights and technical standards will be encouraged. Cooperation in the field of ‘Digital Olympics’ will be promoted.”

On cooperation in science and technology the document provides the following comments.

It is essential to promoted China-EU scientific and technological cooperation on the basis of the principles of mutual benefit and reciprocity, sharing the results and protection of intellectual property rights. Joint development and cooperation on generic technologies should be stepped up and Chinese institutions are encouraged to participate in the EU Framework Program for Research and Technological Development. China will, on the premise of equality and mutual benefit and a balance between interests and obligations, participate in the Galileo Program and enhance cooperation in international “big science” projects. Full play should be given to the role of the Scientific and Technological Cooperation Steering Committee and efforts

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<sup>17</sup> China’s EU Policy Paper, October 2003 (informal version of full text)

should be made to ensure a successful China-Europe Science & Technology and Innovation Policy Forum. Cooperation between scientific and technological intermediary agencies of the two sides as well as the interflow and training of scientific and technological human resources should be encouraged. Support should be given to Chinese and EU enterprises in their involvement in scientific and technological cooperation

### Chinese participation in EU Framework Programme for Research and Technological Development

Chinese researchers and research institutions have been active participants in a number of projects under the Fifth Framework Programme for Research and Technological Development. Chinese participation has occurred in 76 project contracts with a total number of 771 participants from the Chinese side. These projects have received €67.8 million of which €9.2 million has been allocated to Chinese participants. See table.

FP5 China (CN) : Participation & Contribution by Specific Programme					
Specific Programme	Number of participations in FP5 China (CN)	Number of contracts with at least one participation in FP5 China (CN)	Total number of participations in contracts with at least one participation in FP5 China (CN)	EC financial contribution to contracts with at least one participation in FP5 China (CN) (euros)	EC financial contribution for FP5 China (CN) partners (euros)
QOL	8	6	88	7 284 666	8 700
IST	17	10	77	14 995 401	330 551
GROWTH	6	5	132	6 945 571	0
EESD-ENVIRO	5	4	41	2 999 103	7 378
EESD-ENERGY	18	11	124	6 968 385	397 637
EURATOM					
INCO	87	39	297	28 115 904	8 539 187
IHP	2	1	12	420 000	0
INNO					
?					
<b>Grand Total</b>	<b>143</b>	<b>76</b>	<b>771</b>	<b>67 729 030</b>	<b>9 283 453</b>

A number of the Sixth Framework Programme already involve Chinese participants which is exemplified the following table.

<b>Sixth Framework Programme - Projects starting in 2003</b>			
1	MAGNET	This proposal constitutes a system approach to Personal Area Network (PAN) style networking. The concept is extended into that of a PN by interconnecting PANs with, in particular wireless wide area networks to access the rich services available on and through these networks, including the interconnection to other PANs. The project has a strong potential to provide the required enabling technologies for innovative services under a personal communications framework. Moreover this may assist the transition to next-generation wireless systems.	<u>Beijing University of Posts and Telecommunications.</u> This university contributes to the adaptive MAC layer and radio resource management issues. <u>Shanghai Institute of Microsystem and Information Technology.</u> Main contribution is on MIMO aspects.
2	WINNER	The basic objective of this proposal is to develop a ubiquitous radio system concept providing wireless access across a range of applications and environments. This includes optimised usage of a range of radio interfaces, with common control. This proposal is considered important for the Community, especially in the context of the preparatory work for WRC 2007, which will have to assess the frequency requirements for systems beyond 3G	<u>China Academy of Telecom Research.</u> This organisation is linked to the Chinese regulator and will help to establish a global network of contacts in view of the preparation of WRC 2007. Nokia China. R&D. This entity will complement the work of Nokia Finland and provide the appropriate relay towards Chinese players.
3	ALVIS	The ALVIS proposal investigates semantic technologies to enhance The next generation of search engines. The key strength of ALVIS is its potential impact on search engine technology at a European level. its main weakness is that certain elements of The project plan require clarification. The proposed resources are deemed to be over-estimated.	<u>Tsinghua University</u>
4	PIPS	The project has the objective to develop a Health and Life Knowledge services support environment that enables:- HC professionals to deliver personalised prevention focused Health Services;- Citizens to make informed decisions concerning therapies and nutrition (ISTAG based) by exploring innovative IT-research on decision support, knowledge management and trust tools;- development of solutions for personalised services for a configurable platform- creation of awareness (through pilots, publications etc.) to all stakeholders in the life value chain.	<u>Shenyang Neusoft,</u> China: Market leader for location based services
5	ECOSPLAN	The objectives of this good proposal are to carry out a joint EU-China strategic planning of the Beijing Digital Olympics Programme. The evaluators found this proposal particularly important as it is expected that the results, i.e. the specification of an integrated technological platform and the list of associated services, will become the blueprint used to select IST companies in the context of Digital Beijing 2008.	<u>Beijing Municipal Office of Information</u>

6	SENSATION	Advanced Sensor Development for Attention, Stress, Vigilance & Sleep/Wakefulness Monitoring: SENSATION addresses the social diseases introduced by excessive fatigue and sleep loss. It aims to explore a wide range of micro and nano-sensor technologies to achieve unobtrusive, cost effective, real time monitoring and prediction of human physiological state in relation to wakefulness, fatigue and stress everywhere and for everybody.	<u>Beijing University of Aeronautics and Astronautics</u>
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The addition to the projects in list of other projects with Chinese participation have also started during 2003. Three of the projects initiated during 2003 have substantial budgets which include MAGNET with a budget of €23.9 million, WINNER with a budget of €31.8 million, and SENSATION with a budget of €26.1 million.

## Collaboration in Space and Energy

### Galileo

Space research is one of the priority areas in China's high-technology development program and a recent report from Congressional Research Service includes the following statement on China's Space Program<sup>18</sup>.

China is very interested in international cooperation in space. The 2000 White Paper discusses it extensively, and China has cooperative arrangements with several countries, including Russia, Brazil, and Europe. There is no government-to-government level cooperation between China and the United States, although the National Aeronautics and Space Administration (NASA) has reported in the past that it has engaged in low level scientific cooperation, data exchanges, and participation in multilateral coordination groups with China. China inaugurated use of a receiving station for acquiring data from U.S. Landsat Earth remote sensing satellites in 1986. The U.S. trade magazine *Aviation Week & Space Technology* reported in its April 1, 2002 edition (p. 27) that NASA and the State Department were exploring "whether and how to bring China into close cooperation with the U.S. in space," but there has been no public announcement of new cooperative agreements since then.

The report further discusses the scope of China's space-cooperation with Europe and provides the following information. China has cooperated with several individual European countries. For example, Sweden launched its Freja satellite on a Chinese launch vehicle in 1992. China also is cooperating with the European Space Agency (ESA). ESA and China are developing scientific research satellites called Double Star for magnetospheric studies. The two Chinese-built satellites will carry five ESA sensors. China and the European Union (EU) signed a cooperative agreement in September 2003 for China to participate in the EU-ESA Galileo navigation satellite system. This will be similar to the U.S. Global Positioning System (GPS).

China's existing navigation satellite system, Beidou, uses satellites in geostationary orbit. It is a different technical approach than that used by GPS and Galileo (and Russia's GLONASS), and provides only regional, rather than global, coverage. The cooperation agreement of a civil global navigation satellite system (GNSS) – Galileo – includes the following details from the agreement signed in October 2003<sup>19</sup>.

"GALILEO" means an autonomous civil European global satellite navigation and timing system under civil control, for the provision of GNSS services designed and developed by the Community and its Member States. The operation of GALILEO may be transferred to a private party. GALILEO envisages one or more services for open, commercial and safety of life purposes; GALILEO local elements are local mechanisms that provide the users of GALILEO satellite-based navigation and timing signals with input information, extra to that derived from the main constellation in use. Local elements may be deployed for additional performance around airports, seaports and in urban or other geographically challenging environments. GALILEO will provide generic models for local elements;

<sup>18</sup> Smith, Marcia S., CRS Report: China's Space Program: An Overview, Order Code RS21641 Released: Friday, November 14, 2003

<sup>19</sup> Cooperation Agreement on a Civil Global Navigation Satellite System (GNSS) – Galileo, Between the European Community and its Member States and the People's Republic of China

The sectors for cooperative activities in satellite navigation and timing are: scientific research, industrial manufacturing, training, application, service and market development, trade, radio-spectrum issues, integrity issues, standardisation and certification and security.

The Parties shall promote joint research activities in the field of GNSS through European and Chinese research programmes including the European Community Framework Programme for Research and Development, and the research programmes of European Space Agency, and the Ministry of Science and Technology of China.

The Parties encourage and support the cooperation between the industries of the two sides, including by the means of joint ventures with the objective of setting up of the GALILEO system as well as promoting the use and development of GALILEO applications and services.

Exports by China to third countries of sensitive items related to the GALILEO programme will have to be submitted for prior authorisation by the competent GALILEO security authority, if the authority has recommended to the EU Member States that these items be subject to export authorisation.

The joint research activities should contribute to planning the future developments of a GNSS for civil use. The agreement shall remain in force for a period of five years from the date of its entry into force. Thereafter, it shall be extended automatically for further periods of five years each.

Galileo, that is scheduled to become operational in 2008, will encircle the globe with 30 satellites in medium earth orbit, with 27 operational satellites and three in reserve, and will have two control centres on the ground<sup>20</sup>. Galileo opens future areas of collaboration, e.g. in areas of air traffic management, ship navigation, location based services, where already a joint venture exists between Thales<sup>21</sup> and the Chinese Space Industry Corporation, train location services for which a project with the Beifang Jiaotong University of Beijing has already been established, monitoring of the earth by seismological institutes, emergency response and catastrophe management, etc. It is estimated that the economic fallout of the Galileo collaboration will be several times bigger than the Galileo collaboration itself<sup>22</sup>.

## ITER

Europe has together with Japan been one of the major proponents of ITER, which means "the way" in Latin - an international fusion energy research and development project with the goal of taking the next major step in the development of fusion energy as a safe, clean and sustainable energy source. The ITER International Fusion Energy Organization is the entity that will implement ITER.

An historic landmark was realized in February 2003 at the Eighth ITER Negotiations Meeting, when delegations from the People's Republic of China and the United States of America joined those from Canada, the European Union, Japan and the Russian Federation in

<sup>20</sup> China, EU sign agreement on Galileo, China Daily October 31, 2003

<sup>21</sup> Thales Group based in France has joined the Galileo consortium and has top expertise in satellite navigation applications, which will contribute the success of the project

<sup>22</sup> Private communication to the author

their efforts to reach agreement on the implementation of the ITER international fusion energy research project. The decision by China is based on two main considerations. First, ITER would be the world's largest international cooperative research and development project next to the space station and would be constructed over 10 years and operated over 20 years. China wants to show that it can collaborate in a major international project as a first-class partner. Second, China is well aware of its future energy problems for which fusion energy can be an answer in the long term.

The Head of the Chinese Delegation indicated, at the time of signing the agreement, “that China, as the largest developing country in the world, has a great need to pursue alternative energy sources. China believes that ITER can potentially lead to new forms of energy and contribute to the peaceful and sustainable development of the world in the long-term. China expressed its strong wishes to be a valuable member of the ITER family, to make joint efforts with other partners to the successful exploitation of fusion energy”<sup>23</sup>.

The exchange of delegations preceding the signing of the ITER collaboration, and visiting plasma physics laboratories and relevant industries in China, clearly indicated that the Chinese side would be able to make in-kind contribution of satisfactory quality to ITER construction. The delegation of ITER negotiators that visited Beijing in November 2002 was impressed by the speed with which the Chinese authorities had made their decision to participate in ITER negotiations. Further on, the MOST Minister, Mr Xu Guanhua, in a letter in January 2003 requested that China participate in the ITER negotiations and pointed out that China intends to provide a substantial contribution to the Project, which would be comparable to what is envisaged by some of the participants in the then ongoing negotiations<sup>24</sup>.

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<sup>23</sup> The Ministry of Foreign Affairs of Japan, Joint News Release: CHINA AND THE U.S. JOIN ITER NEGOTIATIONS - Site assessment shows all four potential locations meet ITER criteria, Source: [http://www.mofa.go.jp/policy/s\\_tech/iter/joint0302.html](http://www.mofa.go.jp/policy/s_tech/iter/joint0302.html)

<sup>24</sup> [http://www.iter.org/ITERPublic/ITER/new\\_text-Jan03.html](http://www.iter.org/ITERPublic/ITER/new_text-Jan03.html)

## ***Scientific Collaboration between EU and China – A Bibliometric Perspective<sup>25</sup>***

The following section draws on information gained from a bibliometric study which was carried out to find out to what extent the results from R&D in China is reflected in number of articles published by Chinese scientists in internationally recognized journal. It was also possible to identify the expanding relations between scientists in China and counterparts in Asia, US and Europe.

China in the 1950s established links of collaboration with the scientific community in the then USSR and created a scientific infrastructure, with academies ministry-controlled research institutes, that was basically a copy of the Soviet structure. Until the Cultural Revolution (CR) in the mid-1960s it served China in establishing strong footholds in a number of scientific disciplines. The political turmoil that followed from the CR was not over until the end of 1970s and kept China's science community isolated from the rest of the world. From the mid-1980s China has made rapid progress in a number of scientific fields and aggregate figures for publication of scientific articles in international journals is very impressive. In the number has increased from 4,500 articles in 1986 to more than 35,000 in the year 2001. A comparison with the global total shows that China's share has increased from a miniscule 0.63 per cent in 1986 to 3.54 per cent, and the time series indicates that the increase will continue. See Table.

**Table**  
**Global Publication of Scientific Articles and China's Increasing Share**

<b>Year</b>	<b>Global Total</b>	<b>China Total</b>	<b>Percent</b>
1986	717416	4507	0,63
1987	710086	5333	0,75
1988	705729	6496	0,92
1989	654823	6920	1,06
1990	689625	7917	1,15
1991	695688	7938	1,14
1992	741535	9272	1,25
1993	754304	9595	1,27
1994	798220	10133	1,27
1995	854610	13068	1,53
1996	903652	14655	1,62
1997	927161	17004	1,83
1998	959022	19944	2,08
1999	973952	24528	2,52
2000	956418	30501	3,19
2001	999604	35404	3,54

Source: Science Citation Index

(Data mining by Olle Persson & Jon Sigurdson, March 14 2002)

A search in Science Citation Index using the term nano\* reveals that in year 2001 the People's Republic of China appeared in 11.2 percent of nano papers and in 5.5 percent of the

<sup>25</sup> Extracted from

Sigurdson, Jon, NEW STI DEVELOPMENTS IN CHINA, Conference paper prepared for STRATA CONSOLIDATING WORKSHOP: Science and technology policies in Europe: new challenges, new responses, Brussels, 22-23 April 2002

same papers in 1995. This is a much greater share than could be expected from the 3.5 percent of all papers. In 2001 the total number of nano papers was 14,976 of which Chinese published 1,676. In October 2001 China was number 7 among top nations in nano\*, but with very low citation China did not take a top position neither in institutions nor among authors.

More than half of the cities in China have designated nano-technology and nano-materials as one of the most critical research areas<sup>26</sup>. The general belief is that nano-technology, information technology and biotechnology are the three fundamental trends of technological development for the 21<sup>st</sup> century

China is in very strong in material science and during 1991-2000 produced 18,000 papers against 60,000 for USA. China in 2001 took the number 4 position, although with an average citation of 1.6 against 5.5 for US authors. The most cited Chinese papers in material science, on synthesis of gallium nitride at Tsinghua University, received 185 citations. In engineering China took, also in 2001, the number 9 position with an average citation of 1.5 against an average of 3.6 citations for US authors.

The changing character of the Chinese scientific community is also evident when looking at the evolution of co-authorship between Chinese scientists and colleagues in the TRIAD regions. The co-authorship with colleagues has increased 6-fold with the US, 10-fold with EU and 15-fold with Asia Pacific – and is rapidly increasing. See Table.

**Table**  
**Co-authorship of Scientific Papers – between China and TRIAD Regions**

	<b>USA –China</b>	<b>EU – China</b>	<b>Asia Pacific - China</b>
1986	509	337	154
1987	564	443	137
1988	650	532	198
1989	713	619	266
1990	786	765	319
1991	876	869	314
1992	1000	1077	404
1993	982	1214	451
1994	1012	1257	556
1995	1306	1536	712
1996	1453	1739	905
1997	1559	2004	1144
1998	2007	2427	1390
1999	2254	2607	1726
2000	2584	2785	1951
2001	3180	3294	2395

Source: Science Citation Index

(Data mining by Olle Persson & Jon Sigurdson, March 14 2002)

Another important indicator can be found when looking at the authorship of articles published in the prestigious scientific journal Science and Nature. The number of articles submitted by Chinese scientists and accepted for publication by these two journals remained quite low until

<sup>26</sup> Nanotechnology continues to receive great attention from Mainland China, Sci-TechFocus, Vol. 2 No. 9 (December 2001) Taipei

the late 1990s and accepted by the journals. During the past four years the number of articles has increased rapidly. See Table.

**Table**  
**PRC Articles in Nature and Science 1986-2001**

<b>Year</b>	<b>NATURE</b>	<b>SCIENCE</b>	<b>Total</b>
1986	8	3	11
1987	5	5	10
1988	1	0	1
1989	4	3	7
1990	6	1	7
1991	7	1	8
1992	2	4	6
1993	4	4	8
1994	9	7	16
1995	9	10	19
1996	9	13	22
1997	5	9	14
1998	11	18	29
1999	15	19	34
2000	12	25	37
2001	21	72	93
Total	128	194	322

Source: Science Citation Index

(Data mining by Olle Persson & Jon Sigurdson, March 14 2002)

## Trade in High-technology

Trade between EU and China has increased very rapidly and the expansion has continued in recent years, which is evident from the figures in the table below. Since 1978, EU-China trade has increased more than 30- fold and reached €115.4 billion in 2002. Data for the first three months of 2003 show a continuing upbeat trend with a growth rate of more than 16%. China is now the third most important non-European trading partner for the EU (after the US and Japan). Excluding trade with Hong Kong SAR, the EU is the third largest export market for China (after the US and Japan) and the second source of imports (after Japan). Whereas the EU enjoyed a trade surplus with China at the beginning of the 1980s, the EU-China trade relations are now marked by a sizeable and widening EU deficit with China (around €47.5 billion in 2002).

The trade balance is to a great extent in China's favour, although exports to China have during 2001-2 increased more rapidly than imports, a trend which has continued in the early part of 2003. The following section introduces an analysis of the high-technology component of trade between EU and China.

**Table**  
**EU-China Trade 2001-2002, in €Million**

	YEAR 2001		Yearly change		Year 2002		Yearly change	
	IMPORT	EXPORT	IMPORT	EXPORT	IMPORT	EXPORT	IMPORT	EXPORT
France	8 343,05	3 551,75	2,3%	3,8%	8 572,2	3 708,5	2,7%	4,4%
Netherlands	10 347,33	1 240,76	23,9%	14,5%	11 827,7	1 570,2	13,3%	26,8%
Germany	18 117,40	12 064,15	6,1%	28,4%	19 058,0	14 494,9	5,2%	19,6%
Italy	7 480,56	3 272,14	6,5%	37,5%	8 307,4	4 018,4	11,1%	22,8%
UK	15 529,86	2 744,34	10,3%	14,8%	16 811,4	2 363,7	8,3%	-13,9%
Ireland	768,26	354,01	-10,6%	113,0%	760,4	547,6	5,9%	60,0%
Denmark	1 466,93	449,79	2,9%	8,3%	1 472,7	541,6	0,2%	18,6%
Greece	884,40	41,05	22,2%	23,5%	1 023,3	60,2	8,7%	22,0%
Portugal	350,83	60,17	-8,2%	14,1%	344,7	80,6	-1,8%	34,0%
Spain	4 417,14	633,75	7,8%	16,7%	4 755,3	785,4	7,7%	23,9%
Belgium	3 961,19	1 484,30	5,1%	17,5%	4 536,6	1 865,9	5,1%	10,3%
Luxembourg	75,09	52,72	-15,3%	-22,3%	74,4	58,9	-7,9%	-1,2%
Sweden	1 809,10	1 743,19	-2,6%	-14,7%	1 786,7	1 502,7	-1,2%	-13,1%
Finland	866,71	1 264,75	-6,6%	-9,6%	952,0	1 207,6	9,8%	-4,5%
Austria	1 044,23	852,44	24,0%	48,2%	1 162,5	1 177,8	11,2%	34,5%
EU15	75 462,09	29 809,31	8,3%	18,2%	81 445,1	33 983,8	7,3%	13,0%

Source: [http://www.delchn.cec.eu.int/en/eu\\_china\\_wto/1-12%202001.xls](http://www.delchn.cec.eu.int/en/eu_china_wto/1-12%202001.xls);  
[http://www.delchn.cec.eu.int/en/eu\\_china\\_wto/1-12%202002.xls](http://www.delchn.cec.eu.int/en/eu_china_wto/1-12%202002.xls)

Currently, China and the EU have become each other's third largest trade partners. The EU is also the fourth largest foreign direct investment sources and the largest technology import source for China.<sup>27</sup>

<sup>27</sup> China, EU sign agreement on Galileo, China Daily October 31, 2003

Western Europe<sup>28</sup> has been the second most important source of high-tech products (almost one fifth of China's high-tech imports). In contrast with Asia, West-European high-tech products are mostly capital goods. European transfers of technology to China follows a more traditional pattern, as they are aimed at modernising investment capacity and not at re-exports. China's imports of high-tech products from America are evenly distributed between capital goods and parts and components. America ranks second as a market for Chinese high-tech goods (with one fourth of China's exports), far ahead Western Europe (14%).

It is worth stressing that although the EU stands far behind Asia as a supplier of high-tech products to China, its exports are, on average, more high-technology intensive than Asian exports. This is also the case of American exports to China: 20% of China's imports from the EU consist of high-tech products, 17% of its imports from America, against 12% in the case of imports from Asia (15% of imports from Japan). Despite geographic distance, traditional complementarities between China and Europe constitute a large potential for technology transfers.

**Table**  
**Breakdown of China's Trade in High Technology Products by Production Stages and Major Zones, 1999**

	Asia	W. Europe	America	Others	World
<b>Imports</b>					
Semi-finished pro.	3	1	1	0	5
Parts & components	43	7	9	0	59
Capital goods	10	15	9	1	35
Consumption goods	0	0	0	0	1
<b>All Stages</b>	<b>56</b>	<b>23</b>	<b>19</b>	<b>1</b>	<b>100</b>
<b>Exports</b>					
Semi-finished pro.	6	2	2	1	11
Parts & components	30	5	10	2	47
Capital goods	20	5	10	1	37
Consumption goods	2	1	3	0	6
<b>All Stages</b>	<b>57</b>	<b>14</b>	<b>25</b>	<b>4</b>	<b>100</b>

Source: Françoise Lemoine et Deniz Ünal-Kesenci, ASSEMBLY TRADE AND TECHNOLOGY TRANSFER: THE CASE OF CHINA, Centre d'Études Prospectives et d'Informations Internationales, Paris 2001

<sup>28</sup> Extracted from Françoise Lemoine et Deniz Ünal-Kesenci, ASSEMBLY TRADE AND TECHNOLOGY TRANSFER: THE CASE OF CHINA, Centre d'Études Prospectives et d'Informations Internationales, Paris 2001

## ***Industrial technology Collaboration***

European companies have, aside from Airbus at an early stage involving subcontractors, been involved in a number of large high-technology projects. China is in Shanghai building the world's first commercial maglev railway line that will cover the 30 kilometres between the new Pudong International Airport and Shanghai City. The project is based on collaboration between China and Germany and is using state-of-the-art technology and engineering designs. The technology involved in the project has not been commercially used before. The construction was completed in early 2000 and test will be completed by the end of the year<sup>29</sup>.

Another successful example of collaboration is the third 3G standard for mobile telecommunications that was developed in joint project between Datang in China and Siemens in Germany. Although Datang and Siemens jointly developed the TD-SCDMA standard, Datang's partner had been more committed to WCDMA than TD-SCDMA until recently when the radio spectrum assigned to the TD-SCDMA standard was made; at that time, Siemens announced the injection of a further €50 million to strongly advance the standard's development.<sup>30</sup> However, after China's WTO entrance, import tariffs for chips and handsets will be decreased from 10% to 6% and from 12% to 3% respectively, which will discourage domestic firms to utilize indigenous technology, if it is inferior.

The latter project exemplifies possibilities for deeper collaboration not only in technological development but also in industrial research. At the same time a number of Chinese companies have established R&D centres in European countries, although many of them are still listening windows. However, Huawei Technologies a leading telecom equipment company with headquarters in Shenzhen illustrates a new approach with a R&D centre located very close to Ericsson headquarters in Stockholm, which now employs close to 100 staff. Huawei that made a first move a couple of years ago has now been joined by ZTE (Zhongxing) that has indicated that it expand from a presently small scale to a substantial R&D centres when the market for 3G telecom equipment takes off.

However it is in China that foreign R&D centres and research laboratories have started to mushroom to exploit low-cost and high-quality manpower for which Ericsson provides a good illustration. The number of Ericsson design centres around the world has during the past couple of years been drastically reduced – although with expansion in China. The design centre in Shanghai is now expanded to some 250 people and a major activity is development and maintenance of the MSC product – Mobile Switching Centre. This is software development based on the original Ericsson concept for AXE 10, which remains an important technology platform. The design centre in Shanghai will make the necessary ongoing development of MSC for 3G infrastructure.

Ericsson is today establishing a design centre for the development of radio base stations in Beijing and will eventually, by the end of 2003, employ some 100 staff. The purpose is

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<sup>29</sup> It was reported that the German team at the formal start of the project delivered a 400 page manual and suggested to the Chinese counterpart that actual construction could start when the Chinese team had studied the manual and was fully aware of its responsibilities. The next morning the Chinese appeared with a full Chinese translation of the manual and stated after having studied the text was completely ready to immediately embark on construction.

<sup>30</sup> *Economic Observer* (in Chinese), 26 October 2002.

twofold. First, the new design centre will develop radio base stations in such a way that new designs will enable lower cost production. Second, the design centre in Beijing will establish close relations with sub-contractors in China which will increasingly manufacture radio base stations, thereby reducing production costs in themselves.

The new manager of Ericsson R&D in China arrived in the autumn of 2003 and has been responsible for the expansion of the Shanghai which expanded following the transfer of the MSC activities. The Beijing centre has incorporated the earlier R&D joint activities with Datang and in early 2003 employs some 50 people. The advantages in developing radio base stations in China are:

- the engineers in China are available at much lower costs, in the region of RMB5-15,000 per month, although partly offset that several expatriates are initially needed, for reasons of contacts within Ericsson, and because high level management skills are still difficult to find in China
- the product will be cheaper to manufacture
- strategically it was important to expand R&D in China in order to satisfy demands of China's industrial policy

## ***Sweden – an Illustration***

Major areas of academic co-operation between Sweden and China (excluding social sciences) exist in agriculture, environment and medical sciences. A major single area is Water Use Efficiency 2002-2004 – a project sponsored by INEC/Sida with 3.8 million SEK. Cooperating institutions are Umeå Agriculture University and Shanxi Academy of Agricultural Sciences.<sup>31</sup>

The Royal Swedish Academy of Engineering Sciences ( IVA ) is in a final stage of negotiation for an initiative for a project with a concentration on two areas – one on environment, with a focus on bio-environment and renewable energies, and another one on new technologies, with a focus on information and communication technologies. This initiative has been formulated in cooperation with The Chinese Academy of Engineering, which will cover 25% of costs.

Significant projects in medical sciences are located at Karolinska Institutet and Lund University respectively - in Public Health and Orthopedics. However, recently natural sciences with strong indication on technology applications are becoming increasingly important. Individual projects in these fields are not very big yet and are found in several fields and universities. The easiest way to monitor this phenomenon is to check the applications awarded by major sponsoring institutions.

Major sponsoring state agencies in Sweden are: SIDA/Sarec and the Linnaeus-Palme Program of the Ministry of Education. Minor roles are played by Royal Academy of Sciences (KVA), various Swedish Science Councils and recently Invest in Sweden Agency (ISA). One of the substantial funding pools is managed by SAREC - “The Asian- Swedish Partnership Programme”. The projects in this program are assessed in cooperation with The Swedish Research Council (Vetenskapsrådet). Out of forty-one (41) applications delivered for project support with countries in Asia there were twenty-one (21) applications for Sweden China co-operation in the year 2002 out of them 14 were accepted and sponsored. Biggest amount of projects accepted ( 06 ) were in natural sciences with a strong focus on high technology applications. Four ( 04 ) projects were in biological sciences with direction into environment and agriculture. Two projects were in social sciences and two in medicine and one in engineering. The Linnaeus-Palme Program has been in operation from year 2000 and functions under the auspices of Ministry of Education within the system of state agencies responsible for science and education. Until recently 25 projects has been sponsored with an amount of 2.6million SEK. Since starting the Linnaeus-Palme program there has occurred substantial growth in technical sciences cooperation between Sweden and China.

Funds for mutual exchange in science and technology activities between Sweden and China are flowing from many different sources. Universities in both countries, private institutions and companies, international organizations, government institutions and special agencies contribute to various projects. The Royal Academy of Sciences (KVA) - sponsored yearly about five to seven projects although awards cover only travel and accommodation costs, mainly on the basis of exchange with Chinese Academy of Sciences (CAS ). The Swedish

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<sup>31</sup> The Swedish Agricultural University of Umeå has the longest and a very rich tradition in co-operation with China.

Environmental Research Institute (MISTRA) and Tianjin Academy of Environmental Sciences co-operates in project of Industrial Wastewater Treatment.

### **Chalmers University of Technology (CTH): Strategy for cooperation in China**

CTH has formulated its China strategy in the following way

1. Identify strong research environment/clusters
2. Make the exchange of students and researchers mutual so that Sweden is not only at the receiving end, which will require long-term research collaboration involving young researchers and exchanges with selected universities
3. Improve the reception CTH of undergraduate and PhD students coming from China
4. Identify the whereabouts of students and researches who have previously studied or done research at CTH

In light of this CHT has decided to establish working relations with a select number of high-ranking universities which include.

- University of Suzhou, since 1994
- Tsinghua University in Beijing, since 2000
- Fudan University in Shanghai, since 2001
- Jiaotong University in Shanghai, since 2001
- Shanghai University, since 2003
- University of Science and Technology of China (USTC), in Hefei
- Central Iron and Steel Research Institute (CISRI) in Beijing, since 1999

Active research collaboration is presently carried out in the following areas, where collaboration has mainly been maintained by young researchers.

- Hydrology – University of Suzhou
- Material sciences – Tsinghua University, CISRI and Fudan University
- Electric Power Technology – Jiaotong University

**Collaboration in Material Sciences.** Early contacts were established in the mid-1990s and involved exchange of PhD students and researchers and resulted in joint publications. Contacts were later on established with the Ministry of Science and Technology (MOST) in Beijing and as a result CTH in 2001 organised a Swedish-Chinese Material Sciences Symposium – as part of the bilateral agreement between the two countries. Subsequently CTH suggested that a wider network should be established in Sweden in order to stimulate a deeper and more open collaboration between scientists active in material sciences in Sweden and counterparts in various locations in China.

Thus CTH proposed a Sino-Swedish Microsystem Integration Technology (SMIT) Centre as an initiative that will have joint activities both in Gothenburg at CTH and in Shanghai. The local government in Shanghai has offered to economically support the project once an organizational platform has been established. This would involve a substantial commitment from CTH and CTH has also been exploring the interests of MOST that might support the creation of a centre in Shanghai that could draw on resources at Jiaodong University, Fudan University and Shanghai University.

The proposed SMIT would be based on CTH research on micro-technology production and is supported by material researchers and by the micro-technology centre, MC2, that has been

established at CTH. CTH has chosen to give priority to SMIT rather than a centre focused on material sciences as SMIT could simultaneously provide an opportunity to follow what research is being pursued in Chinese material sciences. SMIT would have a focus on world-leading research on electronic packaging and would provide exposure to research being carried out at CTH – in particular the activities of MC2.

There exists a variety of methods in sponsoring individual projects although some of them are not financed as specific Sweden–China co-operation projects and are not easy to monitor through major organizations and funds delivering money for this kind of activity.<sup>32</sup> There are increasing attempts to use European Union for co-funding mutual Sweden–China projects. Chinese institutions such as Academy of Sciences (CAS) and responsible ministries also participate actively in sponsoring mutual projects. Some private companies in Sweden are another example of funding mutual research between Sweden and China universities.

The most active academic centre in Sweden for China cooperation is Lund University. Lund University researchers were awarded funding for four (04) projects from SAREC grants, Karolinska Institutet was sponsored for two (02) projects and Uppsala University got support for two (02) projects also. Five other projects were distributed among five different institutions such as: SLU Uppsala, Chalmers University of Technology, Luleå University of Technology, Karlstad University, Stockholm University and Örebro University. The major beneficiaries of funding from the Linnaeus–Palme Programme were University of Gävle, Institute of Technology, and Lund University, Institute of Physics and Institute of Sociology. Lund University is also the major beneficiary of KVA sponsorship.

The information above does not provide a complete coverage of cooperation in science and technology between Sweden and China, although it gives a respectable presentation of activities within the academic community in Sweden. However, private sector cooperation is likely to become more important. One example is Tetra Pak funding of a Young Masters Program in China (pilot phase) together with Lund University – the International Institute for Industrial Environmental Economics – with an amount of some two million SEK. Another example is Biomet Merck in Sweden that is co-sponsoring orthopaedic project together with Lund University and TYF Medical Device Company in China.

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<sup>32</sup> Example may be natural sciences project between: Lund University, Division of Experimental High-Energy Physics, Department of Physics and Nanjing University, Physics Department in the project experiment at future hadron colliders. This co-operation is totally sponsored only by funds of the institutions involved.

## ***Concluding remarks***<sup>33</sup>

China is strong in terms of technologies in a number of areas and has plentiful skilled human resources and China's membership of the World Trade Organization has provided a window of opportunity for transforming such technological and human assets into economic wealth. New and expanded possibilities exist within three areas – in business, in science and technology and in the political domain.

### The Business Community

Since China in the early 1980s embarked on its open-door policy, manufacturing companies from all over the world have congregated in China to exploit the prospects for substantially lower costs combined with a relatively skilled and disciplined labour force - not to forget the huge domestic market potential. During the past 20 years China has emerged as the "workshop of the world" leaving Japan behind. It would be a great mistake to continue to view China as the "workshop". China is rapidly advancing in many technological fields, although its technological prowess still lags behind. Thus, there is a need to develop efficient monitoring systems and EU companies could benefit from developing a forward-looking view on China becoming a knowledge-based economy.

China requires investment flows both into infrastructure and new facilities as well as technical renovation projects. The second category generally requires less investment and yields higher benefits. China continues to attach great importance to introducing advanced foreign technology to upgrade existing enterprises. A number of conditions have to be met: 1. Providing advanced and appropriate industrial technology and equipment to existing enterprises 2. Experts are needed to diagnose problems facing enterprises in Asia; 3. Exchange of information and personnel is essential that will also include management expertise; and 4. The Chinese situation in particular requires special attention to state-owned enterprises and the large number of rural and village industries.

The rapid development of the IT industry in China, in particular within telecommunications, has indicated to the rest of the world that is an emerging technological superpower that will offer not only competition but also great possibilities for collaboration.

### Science and Technology Community

China has in recent years rapidly established itself as a potential scientific powerhouse as evidenced by its fast expansion of its share of global scientific production. It can be expected that China will soon create the necessary links between scientific research on one hand and technological development and innovation on the other. Initiatives should be taken to identify barriers to increased technological collaboration, both at the national and corporate levels. There has occasionally been a reluctance among EU members to support Chinese initiatives, which has a direct bearing on possibilities and forms for technological co-operation.

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<sup>33</sup> These comments are partly based on work related to a report commissioned by the Directorate for Research and Technology Development (RTD): Sigurdson, Jon, NEW STI DEVELOPMENTS IN CHINA, Conference paper prepared for STRATA CONSOLIDATING WORKSHOP: Science and technology policies in Europe: new challenges, new responses, Brussels, 22-23 April 2002

There are many weak linkages in research-technology trade that could and need to be strengthened. There are similarly a number of barriers that could and need to be removed or reduced. However, concrete initiatives will be required in order to improve information exchange, the establishment of active networks, and attention should be given to specific issues.

- First, most technology transfer is trade-related and small and medium enterprises are at a disadvantage in both donor and recipient countries.
- Second, although science and technology are closely related it is often necessary to make a clear distinction when it comes to technology transfer and technological collaboration.
- Third, there exist prospects for expanded international collaboration in certain research fields, although it is generally recognised that joint projects are hard to initiate and manage.
- Fourth technological upgrading includes not only technology as such but also the management tools to yield optimal results.
- Fifth a number of barriers, such as IPR, and differing standards, exist at both national and corporate levels that need to be removed or reduced.
- Sixth, there is a need for more information to establish more effective relations in technological co-operation

#### Political Community

There can be little doubt that the emergence of China as an industrial and technological superpower will have far-reaching consequences for the Asia Pacific region as such and for the rest of the world.

One likely outcome is a temporary erosion of competitiveness for products, now produced in other Asia Pacific countries that China can produce cheaper and better. This is likely to prevail for a long period of time, as China will continue to offer low cost labour at increasingly higher skill levels. The interior of China is being drawn in the modernisation process and will offer another huge supply of manpower and also a growing demand for commodities and services. The rest of Asia would have to take steps to improve the productivity of labour, climb the value-added chain, improve their investment climate and develop sustainable sources of national competitiveness.

It is already apparent that different provinces and regions in China will develop at a different pace and that their interests and long-term ambitions offer opportunities for EU to become directly involved with local governments.

Another predicted outcome is the replacement of Japan by China as the major power in technological development. China already today has a labour force in science and technology that equals Japan, although still very inefficiently utilised. The expected changes in the economic-technological regime in Asia Pacific need to be understood at an early stage in order to formulate and implement policies that can handle future challenges and accept changes that will benefit both China and EU.

This paper has highlighted significant changes within the domain of science, technology and industry – with obvious political ramifications. The indicated successful use of resources in China within the domain will in the future have far reaching consequences for the global scientific community, for those active in innovation and technological development and for

large industrial segments. Although this development cannot be predicted foresight studies on possible scenarios will provide vital guidance for those who are responsible for formulating and implementing policies.

A number of concerns have to be addressed. First, there is a lack of linkages between networks in China and those in EU. Efficient and close networks are needed for further facilitating the various forms of collaboration in science and technology. Second, there is a need to gain a deeper understanding of the social transformation that must be carried to promote and transfer science and technology from the densely populated coastal regions to the western regions of China. Third, there is a need to more deeply grasp the remaining hurdles in China in transferring relevant innovations from the laboratory to viable industrial applications.

### A Global Perspective

A new technological landscape is taking shape in Northeast Asia and China will in due course replace Japan as the technological driver in the region. Industrially such a change is already taking place although China still has to scale the technological heights where the US, Japan and EU still maintain dominant positions.

China is benefiting from a tremendous inflow of foreign direct investment which has also brought significant technological inputs, although most of it embedded in foreign industrial and management structures. China is simultaneously expanding and supporting its domestic resources for research and technological development. China is benefiting from the increasingly global nature of commercial high-tech R&D. By combining substantial inflows of technology with its own R&D development China is in the position to greatly profit from the ongoing globalization process, and gaining an advantage over other countries in a similar stage of development.

China has become the main beneficiary due its vast market potential, increasing role in the global economy and its various policies and programs to exploit the potential of the recent international dynamic situation. The global economic forces are creating a new structural relationship with EU, as well as with other global actors of which the US is the most prominent ones. Thus states and regions are competing for shares of the world high-tech markets and changes take place much more quickly than in the past.

There is little doubt that China is becoming an increasingly attractive partner not only in high-tech trade but also joint R&D activities. US may initially have benefited from establishing close S&T relations with China since the late 1979, partly because from a major inflow of Chinese students looking for advanced education and training in highly recognized universities. However, EU has in recent years been able to foster increasingly close relationships in science and technology. The Framework Programmes for Research and Technological Development have become recently provided an attractive platform for promoting collaboration in science and technology. Simultaneously, almost all member states of EU and most of those soon to become member states have on their own initiatives established bilateral relations in science and technology with China.

However, collaboration in big science as exemplified by the recent EU-China agreement to collaborate on the Galileo satellite project can only be carried out at the EU level. Although national cooperation with China will remain important it is to be expected that EU-China

initiatives will increase in importance, partly facilitated by the fact that there is no fundamental conflict of interest between China and the EU and neither side poses a threat to the other.

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