

# Prospects of the International Technology Environment Towards the 21st Century : Lessons from the Collaboration Phenomenon.

## 要 約

과학 기술의 세계화는 기업간의 기술적 전략 동맹 등을 포함하는 R&D 활동의 超國家化 현상을 말한다. 이를 통해 기업들은 R&D에 부수되는 비용 및 위험의 분산뿐 아니라 기술의 이전, 제품의 표준화, 시장의 확보 등을 도모하고 있다. 따라서 과학 기술 세계화에 내재되어 있는 여러 문제점에도 불구하고 세계화의 추세는 다가오는 21세기에도 크게 확산될 전망이다.

그러나 과학 기술의 세계화에 따라 각 개별국의 과학 기술 정책이 여타국에 큰 영향을 미치게 되고, 이것이 국가간의 마찰 요인이 될 수도 있다는 우려와 함께 과학 기술 정책과 관련된 '국제 규범(New Rules of Game)' 수립의 필요성이 선진국을 중심으로 논의되고 있다. 또한, 과학 기술의 국제화, 세계화가 세계 시장을 왜곡시킬 수도 있다는 견해와 함께 이를 감시할 새로운 국제 기구를 설치하여야 할 것이라는 주장도 있다.

따라서, 앞으로의 과학 기술 국제 질서는 국가간 협력의 형태나 운영 방식에 따라 크게 내용을 달리할 수 있을 것이다.

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## Introduction

Before embarking on a discussion of such an important subject as this, two points need to be made :

First, no one but the most enthusiastic futurologist would fail to preface any discussion of future prospects without a suitable word of caution. In a world where in the USSR three days of intense political drama recently destroyed 75 years of accumulated social, economic and political structures, it is definitely unwise to talk of the future with any certainty.

Second, in discussing the prospects for the international technology environment it should be emphasised that science and technology can never be considered in isolation from its economic, social and political contexts. Scientific and techno-

logical change is, of course, profoundly and intricately linked with processes of economic, political and social adjustment, which, in turn, makes future predictions all the more precarious.

Nonetheless, studies are currently being undertaken which are attempting to consider the changing role of science and technology into the next century. An important study in this field is the OECD's Technology Economy Programme. Central in this Programme's analysis is the view that : "...the internationalisation of science and technology has gone hand in hand with an increase in transnational networks and strategic alliances between enterprises as a means to competitive advantage in global markets, increasingly through the joint development of and access to technology. It raises major questions about

the role and grip of government policies, and their relationship to the strategies of such enterprises”

A term used to describe the tendency towards internationalisation of public and private-sector science and technology is *techno-globalism*. Key policy concerns arising from this tendency include new institutional arrangements for dealing with competition policy, and questions of the balance between ‘national’ and ‘international’ policies.

The evidence suggested in support of techno-globalism is accepted to be shaky. However, despite very marked differences in national systems of science and technology and their performance, the broad tendencies of increased international trade and increasingly ‘global’ strategies of multinational companies are cited amongst other things as supporting the techno-globalisation thesis. There are other *a priori* reasons for supporting this argument. It is a commonly held view that many of the global problems facing the world: of large and growing inequalities in wealth distribution and qualities of life; energy and resource preservation; population control; environmental degradation and militarization, to name a few, need *global*, or at least supranational, solutions. It is also believed that science and technology can play a vital role in overcoming these problems.

At the same time, science and technology policies in many industrialised nations commonly share the same concerns and instruments. For example, there is a *convergence* internationally in policy measures to promote collaboration, generate and regenerate industrial and technological activities in disadvantaged regions, encourage the formation and growth of small firms, and develop infrastructural mechanism to improve technology transfer (such as science parks).

If globalisation and convergence in policy are occurring, then science and technology policy-makers might be argued increasingly to be attempting to address common world problems, and that globalisation and convergence will continue to be important elements of the future technological environment. But just how global is science and technology? and what does collaboration include and exclude?

### **The Collaboration Phenomenon**

The promotion of, and support for, technological collaboration between firms, and between the public and private sector, is a central element of the technology policies of many industrialized nations. Collaboration has been an important part of Japanese industrial and technological development. The practice of collaboration has attempted to be emulated in the USA and Europe. In the USA, over 170 consortia have been formed since the 1984 Cooperative Research Act was introduced to shield them from anti-trust legislation. The European Commission has actively promoted collaboration. The Department of Trade and Industry in the UK promotes over 100 industrial ‘clubs’. Studies have shown increased numbers of new collaborations being formed in the early and mid-1980s, and this trend may continue into the 1990s.

### **Incentives to Collaboration**

A number of *technological* reasons can be suggested as incentives to collaboration. Collaboration can help share the high costs of technology development and can reduce duplication of R&D efforts.

Collaboration shares the risk of development. In technologies which are in the process of being widely diffused, such as information technology, there is considerable uncertainty as to the most appropriate configurations of the technology, and the markets in which it is to be used. This uncertainty may be overcome

by collaboration. Collaboration also provides a method by which firms can observe novel technological developments without having to undertake the expense and risk of investing in speculative research.

Collaboration potentially provides a mechanism whereby close linkages between different organisations allows sympathetic systems, procedures and vocabulary to develop which may encourage effective transfer of knowledge. It allows partners to transfer 'tacit' and 'firm-specific' knowledge. Technological knowledge is also difficult to price, but collaboration provides a means of exchange without necessarily resorting to prices. Technology transfer is also assisted by new information and communication technologies.

With many new technical standards being created, both domestic and international, firms may feel their cases for the adoption of particular technical standards may be improved by their promotion by a number of firms, rather than singly. This is particularly apparent within the European Community. Collaboration provides an effective mechanism for the joint creation and promotion of standards. Collaboration is believed to improve the speed of technological development. The Alvey Programme in the UK has been shown to decrease development times.

Some argue the increasing convergence of science and technology. This may provide another reason for increased collaboration.

Additionally, a number of *public policy* and *corporate* reasons can be suggested as reasons for collaboration. Collaboration is a mechanism by which firms in one trading block can gain access to technologies and markets in others. Technological collaboration potentially may provide a mechanism by which tariff and non-tariff barriers to

international trade and investment may be circumvented, and thus be attractive from a governmental and corporate perspective.

Promotion of 'pre-competitive' R&D rests more easily with those governments whose free-market approaches to industrial and technology policy deters more direct intervention in the behaviour of individual companies. This is particularly apparent in the UK where during the 1980s, single-company innovation support was almost entirely removed and replaced by support for collaboration.

Collaboration and less reliance on entirely in-house sources of know-how have become part of the technology strategies of many firms. There are now numerous analysis of firms 'networking' together in a collaborative fashion. Mytelka argues that it is the growing knowledge-intensity of production combined with slow growth associated with economic recession that has stimulated increased collaboration. Economic downturns, she argues, have induced firms to reconsider their strategies for dealing with turbulent markets, and cooperation with other firms has been a feature of these strategies.

#### **Problems with Collaboration**

There are, therefore, many reasons to assume that collaboration will continue to be important in the future. This is a key assumption underlying the OECD's Technology Economy Programme. But how effective has collaboration been? Surprisingly, particularly the high levels of credence given to it, there is limited analysis of the *outcomes* of collaboration. Evaluating the success of collaboration is notoriously difficult. Nevertheless, it is clear that in many cases the potentials of collaboration remain just that, and their realisation is rare. This can be seen in a number of high-profile collaborative programmes: the Japanese 5th Generation

Computer Systems Project; Microelectronics and Computer Technology Corporation(MCC) in the USA, the Alvey Programme in the UK, and ESPRIT in the European Community. The problems experienced by these consortia are indicative of those found in a broader sample.

A number of questions arise in respect to the success of collaboration. These have consequences for those promoting it and its future importance.

– **Dose it reflect technological weakness rather than strength?**

During the historical process of international transfer of the concept of collaborative technology programmes – from Britain to Japan to the USA and Western Europe – expectations of it grew out of all proportion to actual potentials. The model of collaborative research initially promoted in Britain after World War I was based on a concern for declining industrial and technological competitiveness (a decline unfortunately yet to be alleviated). The model was successfully adapted to the conditions of the Japanese economy in the 1950s and 1960s. Thereafter, and following the continuing success of the Japanese economy, collaboration was somehow construed in the West as one of the critical factors explaining that success, and its transfer was fallaciously assumed to be able to help reverse the USA's and EC's declining competitiveness. In his study of the US semiconductor industry, Hobday shows how the 'networking' thesis of firms working together is a sign of collective weakness.

– **How international is collaboration?**

The assumption of the increased globalisation of technological activities is questioned by Patel and Pavitt, who argue that technological development remains an essentially domestic activity. In their study of

the technological activities of 686 of the world's largest manufacturing companies they found that more than 80 percent of these activities were domestic. Foreign participation in publicly-promoted collaborative schemes is low (USA firms find it difficult to participate in European Community schemes, and vice versa, and access into Japanese programmes is notoriously difficult for foreign firms). Arnold and Guy provide a classic case of the dilemma of inclusion/exclusion of IBM's attempts to join the EC's ESPRIT Programme. They argue that IBM is the largest actor on the supply side of several EC member states, it undertakes substantial amounts of R&D within the EC, and that it is not clear whether it has a negative effect on the EC balance of payments. If IBM were to be included, then the EC would be supporting a US firm's research, and allowing it access to European research results. Of more than a dozen IBM proposals to ESPRIT, only one was accepted (presumably to prevent accusations of discrimination).

The 'international' nature of collaboration is also questionable in the respect to the numbers of actually participating countries. Over 90 percent of agreements take place amongst the 'triad'. The non-triad share of agreements is mainly covered by companies in South-East Asia working with triad partners.

– **How much do they focus on technology?**

One of the assumptions concerning the promotion of collaboration is that it is primarily a mechanism for technology sharing.

Studies of the focus of collaboration tend to show, however, that only around one-quarter of collaborations involve joint R&D. And collaboration in development is much more common within the 'triad' of global trading blocks, than between them (an exception is

EC–USA agreements). Production and marketing agreements are much more commonly the focus of collaborations between the triad.

– **How congruent are public policies and private strategies?**

At a time when public policies are generally promoting collaborations, the actual number of collaborations being formed may be *declining*. The MERIT–CATI database of over 7,000 agreements reported in the press and specialist journals shows the increase in numbers revealed by the other studies in the early and mid–1980s, but also shows a decline in the number of agreements being formed in the late 1980s. Reasons why collaborations may be declining include the sheer management effort needed in order to make them work. Other reasons suggested include an end to pre–1992 repositioning amongst European multinationals, and restricted numbers of available partners following the 1980s acquisitions and mergers boom. Dodgson suggests that we will see a future decline in the quantity of collaboration, but an improvement in their quality, i.e. they will be longer–term and more integrated.

– **Are they anti-competitive?**

The assumptions of *positive* benefits of collaboration do tend to ignore its anti-competitive potential. Collaboration is a strategic tool which may be used to block competition, either by raising the scale of resources devoted to a project to deter other firms from attempting to compete, or by tying a partner with specific skills so that competitors cannot gain access to them. Many EC collaborative schemes are argued to be anti-competitive. Soete argues that the creation of oligopoly need not necessarily reduce world competitiveness as old entrenched ‘national champions’ may be removed, and hence competition within

oligopolies enhanced. The question of access into these markets, and the continuance of high entry barrier remain however.

– **How important are new management skills?**

The management problems of collaboration are extensive. They include the question of partner selection: choosing a partner with complementary technologies and technology and business strategies, and partners with whom long–term relationships based on trust and mutual respect can be built. Effective communications between partners are essential and these are very difficult to build, particularly when the relationship is international. Human resources management is also critical: in the selection and training of project managers, in harmonising conditions between employees in different organizations, and in the provision of incentives. To be valuable collaborations needs to be seen as *learning* experiences. To this end firms need to develop new skills to improve learning capabilities.

**(Techno-globalism: Lessons from Collaboration)**

It has been argued that collaboration is a central feature of the techno-globalisation thesis. There are numerous reasons why firms may choose to collaborate, and policy–makers should promote it. Nevertheless, by examining some of the outcomes of collaboration and the problems with it, a number of important questions arise for the question of growing internationalisation. These include:

- how *international* is globalisation?
- how *technological* is globalisation, and how *advanced* and *appropriate* is that technology?
- how *anti-competitive* is globalisation?
- how *congruent* are the strategies of firms and public policies?

– what new management *skills* of technology are required?

Answering these questions requires much wiser counsel than this author can provide. I would, however, venture so far as to make a number of observations.

First, much more work is needed in examining the whole basis of the techno-globalisation thesis. Is the model actually correct? On the basis of the examination of the problems involved in collaboration, one would have to be sceptical about uncritical acceptance of the thesis.

Second, if the thesis is correct, then it has, of course, as emphasised by the OECD's Technology Economy Programme, profound consequences for policy in considering the 'new rules of the game'. If it is correct, three problems may require particular attention:

– the need to integrate technologically disadvantaged nations, and to ensure greater international attention to technological problems of global significance.

– the need for an effective international institution to control the anti-competitive nature of collaboration. Such an institution is proposed by Soete, and Sharp and Walker argue that the EC is in a favoured position to create such a body. The current tensions found within the European Commission between the Directorates promoting technology and competition show how hard this is going to be.

– the need to develop greater management skills of technology in international linkages amongst firms, public sector research organisations and public policy-makers to ensure that the problems, costs and benefits of internationalisation are fully realised. Greater skills are required of the latter group to ensure congruence between private

strategies and public policies.

Third, if the thesis is wrong, then much greater emphasis is likely to be placed on national systems, and in creating international barriers to technology creation, transfer and diffusion. In such circumstances the likelihood of effective attempts to solve the pressing technological problems are much reduced.

Fourth, irrespective of the accuracy of the analysis of techno-globalism, *indigenous capabilities* remain critically important. This is self-evident if techno-globalism is a mirage, and national systems of science, technology and innovation remain 'national'. But even if techno-globalism is the correct analysis, participation in international arenas and the attraction of foreign company investment depend on domestic (national, regional and local) skills, resources and capabilities. These are important in at least three senses:

– in order to prove attractive to potential partners and investors. This applies, of course, not only to existing attractions, but to *developing* capabilities, skills and resources, and the factor endowments which provide comparative international advantage.

– to enhance the *receptivity* of firms, agencies and research institutions to external inputs, i.e. to enable effective *learning*.

– to provide nodes of excellence on which to base the *diffusion* and *transfer* of know-how and good practice throughout the economy.

This paper has provided more questions than answers, and perhaps this is a more sensible approach. As events in the USSR have shown, things can change radically and very quickly. It is intended to be cautious and to highlight how many problems there are in ensuring that the prospects of science and technology into the 21st century are *positive*. \*