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„Strategic implications for the interaction between Industrial Research and Development and Science and Technology Policy:

The case of the 'countries in transition' "

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1. Introduction

1.1 The new challenges

The scientific community constitutes one of the most valuable assets of the cultural heritage of Europe. The dramatic decline of the scientific and technological potential in all countries in the Eastern and the Central part of Europe, calls for immediate and drastic remedies. Otherwise, the scientific research system, as one of the more vulnerable segments of society, faces the danger not only of temporary disruption but also of lasting damage.

Science and technology can contribute significantly to the adaptation process of the countries in transition. They can help to make the economy of those countries more productive and more competitive. They can help encourage export growth and cut imports. They can also help improve the environment. In the *White Paper* of the European Commission on ‘Growth, Competitiveness and Employment in the European Community’ clear evidence was furnished that the Community has been losing competitiveness.(1) Western Europe’s overall economic performance has been declining both absolutely and in relation to its major competitors. The objective of the Community activities within research and development is, therefore, partly to improve the competitiveness of European industry by strengthening the scientific and technological bases and partly to increase the quality of life for the citizens of Europe. If the ‘health’ of the West European Knowledge System which - though in general rather well funded and rather well functioning - is under increasing challenge from other global players and became therefore a matter of concern to the heads of states and of government of the member states of the European Union, the concerns of those responsible for the ‘health’ of science and technology in Central and Eastern Europe must infinitely greater.

In view of the the increasing global competition. the ‘Greater Europe’ must mobilise all its intellectual resources and technological capabilities.

It is in this context important to note that the mentioned *White Paper* of the European Commission expresses great expectations on the ‘Pool’ of high-level scientific and technological competence still existing within the countries of Central and Eastern Europe. It formulates the hope that the ‘Potential for Innovation’ of both parts of the continent could be mutually exploited and would thus be beneficial for all concerned.(2)

1.2 Scope and focus of this review.

There are many conferences, seminars and ‘round table’ meetings on the ‘*newly emerging economies*’, ‘*newly emerging democracies’* or ‘*countries in transition’*. Among the numerous problems which the Central and East European countries have to solve in their endeavour to become, once again, part of the ‘global system’, the restructuring of their ‘*innovation systems’* is usually not obtaining the attention which the matter deserves. If there are well-meaning efforts to look into the difficult situation of the ‘Knowledge System’ of the countries in Central and Eastern Europe, they are usually concentrating on the ‘*Science dimension’* and rarely, if at all, on the equally important ‘*technological aspects’* of the innovation process of the so-called ‘countries in transition’(3)) This seminar in Wilnius is, therefore, adding an important chapter in the large book of the new science to be known as „Transitology“.**(**4)

My following observations are attempting to highlight some of the issues elaborated at length during the seven years old and still ongoing debate on the new role which *Science and Technology* and *Research and Development* respectively have to play in order to assist the countries in Central and Eastern Europe in their dual struggle to (a) transform their economies into market economies and (b) to adapt and hopefully integrate their 'Science and Technology system' into the 'Knowledge System' of the OECD countries. The focus of this paper is on the crucial but not always well understood interaction between the governmental Science and Technology Policy (STP) on one side with the industrial Research and Development (R&D) Strategy of the private sector, on the other side. The interplay of both is a perquisite for the creation of a viable internationally competitive technological base of the countries concerned. *Science and Technology Policy* will be the vehicle, the tool, among the other sectoral national policies to reach this target.

One set of issues in this paper will address specifically the predicaments of former socialist countries in their difficult itinerary towards market economies. The main part of this presentation will deal with the relationship of the Science and Technology Policy of governments on one side and on the other side with the R&D policy of the private sector, with innovation policy, valid in any industrialised country, regardless whether they are already member of the European Union or whether they are, like the Baltic countries, preparing their way for EU membership. I hate to use the word '*transition countries'* for the countries in Central and Eastern Europe, because since 1989 it became painfully clear to the traditional Western industrialised countries and in particular for my own country, Germany, that they too as part of the globalisation of their economies, are all of a sudden in a permanent 'transition'. The Annual Report of UNCTAD for 1996 has shown that the 'world market share' of traditional industrialised countries like Germany, the UK and even Japan continued to decline since 1989 whereas the unemployment figures are climbing. In contrast to this, the developing countries in South-East Asia as well as the giant country China and others are witnessing a steady increase both in their market share as well as in economic growth.
In the final part of this paper, there will be some conclusions as well as some recommendations for future action.

2.The predicament of the Central and East European countries in general and of the Baltic States in particular.

2.1 The legacy of the past

In the Proceedings of another NATO-symposium on 'Science in Eastern Europe' held in September 1988, we can read: *„Scientific development linked to technology is central to Marxist ideology and to its implantation into government. It is therefore not surprising that science has occupied such an important place in the plans and aspirations of the COMECON (CMEA) since its foundation in 1949. It appears, however, that despite such continuity little has resulted to benefit the populations at large. Some spectacular scientific and technological results have been achieved in a few areas, for example space in the Soviet Union - COMECON's dominant partner - but all the nations still rely largely on outdated, sometimes primitive, infrastructures and procedures...*"(5)
It is one of the most unexpected and sobering discoveries in the former COMECON countries that this region which possessed only a few years ago more than 2 million scientists and engineers performing R&D - roughly equal to all OECD countries combined, including the United States and Japan - is today only of marginal interest in the field of science and technology to Western countries. We see here the unfortunate consequences resulting from the separation of R&D facilities (in the former COMECON countries) from the production process, or, how state support was handed out on the basis of institutional reputation instead of on the basis of the technical merits of the specific projects in question. Another related problem was the inflexible Socialist system of central planning, i.e. the so-called *'Comprehensive program...*" of COMECON. Research, Development and Innovation are basically an exploration of the unknown. Many creative discoveries or technical solutions are surprises. Thus, the choice of important research themes at the 'All-Union' ministry level in

Moscow or through the "*science and technology five years integrated programmes'* of COMECON worked to the disadvantage of creative, pathbreaking research. (6) The so-called '*Basic principles of the international socialist division of labour*' as well as '*The Organisational, Methodological, Economic and Legal Principles Governing the Scientific and Technical Cooperation of the CMEA Member-Countries and the Relevant Activities of the CMEA Bodies'* (7) introduced by COMECON have resulted in production and research facilities which are oversized for the former Soviet Republics once they became again independent.

2.2 The assessment of the situation by Western observers

Many efforts have been undertaken during the last years to evaluate the Science and Technology systems of the former COMECON countries.(8) Unfortunately, no systematic approach to this effect was made and no internationally comparable methodology was used. Therefore, the results are inevitably sketchy. The implementation of the - non-binding - recommendations is for obvious reasons very difficult since they had not only to overcome the vested interests of those immediately concerned, the situation was furthermore made more complicated since most of the evaluated countries had to witness since 1989 not only *one* drastic change of government, but in some cases *several* new teams of ministers and of parliaments with fast changing majorities. As often seen in similar situations, each successor usually rejected the decisions taken by its predecessor. As a result, the drastic shrinkage of funds and personnel in the Science and Technology systems of all former socialist countries is 'not the result of active planning of national priorities and for the corresponding resources needed to accomplish them. Rather it is the consequence of a collection of individual decisions that have left institutes with those employees not necessarily best suited for current and future needs.'(9) The only case, in which the findings of Western evaluation teams have been fully applied is East Germany. As an immediate consequence (see below), the local S & T potential has been drastically reduced (almost by 80%) and most teaching positions herb been filled by West German faculty staff

2.21 Industrial Research and Technology

After the fall of communism in 1989, the world scientific community devised bilateral as well as multilateral assistance programs for their colleagues in the former socialist countries. They also offered expert advice for independent international evaluation of the Science and Technology systems in these countries. Western Industrialists also were ready to make special efforts to make the industry in Central and Eastern Europe an integral part of their world-wide Cupertino and marketing efforts. In addition, many industries from Western Europe, from the United States and from other parts in the world regarded the sudden new political situation in these countries as a chance to buy high level technology at cut rate prices. To quote one example, *Siemens* together with *Daimler-Benz* have entered with Russian partners into a Joint-venture with offices in Moscow, St. Petersburg, Munich and Stuttgart with the special mission to screen available technologies in Russia for joint exploitation in Western markets.(10) Western industries were furthermore ready to invest heavily in some of the countries in Central and Eastern Europe and to open offices. Today, after several years of activities in this region - according to opinions voiced at two independently organised but related meetings of top representatives from the West European industry -„*the overall results are limited*“(11): Not only did companies find it difficult to locate the high-tech products and processes in Central and Eastern Europe, but when such data was found, it was even more difficult to integrate it in Western plants and production systems.

Things are not facilitated by the fact that those in charge of R&D in Central and East European countries find it difficult to accurately define what it is that they can contribute to each potential co-operative arrangement.
Moreover, according to the same reports, as far as Co-operation in joint research projects is concerned, the experiences are, in general, not very encouraging. The reasons for this are complex. As an alternative to in joint projects, industry now takes a different approach. Although some co-operation (in joint research and development projects) still exists, most Western industries export their own technologies and know-how, and train East Europeans to work with this. In this context, taking over industries in the East mostly means buying a site at a low price, then replacing it by a completely new factory which functions with modern Western technologies. In other words, the Western industries found that it is cheaper to build new factories than to modernise the old East European ones, which are generally considered to be „*big and inefficient*“.

In more detail, the following findings were reported by representatives from large Western technology-based enterprises:
„In Eastern Europe's R&D one may expect top science, exceptionally good basis education, surprising enthusiasm, ingenuity, especially to overcome problems, eagerness to succeed and willingness to learn and to adapt with respect to language, culture, modern technology. By Western standards salaries are extremely low, which means that carrying out specific tasks can be very inexpensive.

There are, however, substantial obstacles: low technological level, social instability and mutual mistrust of the researchers, poor communications, great difficulties due to differences in culture and language (in spite of the above mentioned eagerness to overcome them) and lack of security with respect to intellectual property rights.

The substantial part of R&D in the Communist countries has been carried out in research institutes rather than in universities and industrial companies, and had been devoted to military objectives. There is generally no notion of Western concepts such as marketing.

At present, due to the economic situation, R&D links to former Communist countries cannot be effectively used as a key to the potentially enormous market. They are, instead, an investment for the future, which seems to be necessary in order to preserve stability and to avoid an even greater brain drain from the East than that has been experienced so far.

Therefore, support by official bodies, e.g. the EC is important. Present EC activities are - possibly due to old established links - directed towards university relations, and thereby lack effectiveness in the improvement of technological relations. Better results could be achieved by:
- *supporting modernisation of the infrastructure in Central and Eastern Europe (e.g. in the field of telecommunications).*
- *improving the 'boundary conditions' of science and technology in these countries (protection of intellectual property, etc.)*
- *promoting exchanges and co-operation in joint projects involving Western industries.“*

Similar conclusions were reached at a Round Table meeting on „*Co-operation with Central* and Eastern Europe“ held in January 1995 by the Industrial R&D Advisory Committee of the European Commission (IRDAC) under the chairmanship of *Rudolf Bertsch* of Siemens. The

Committee consists of 21 Industrial Research Directors originating from all 15 EU member states:
„The wealth of new scientific and technical know-how in Central and Eastern Europe is not as 'applicable' as Western industry thought it to be six years ago...
Certainly, opportunities and innovations exist here, but the lack of information, inefficient industrial methods and a focus that is far from any of the Western market priorities, make the bright spots in these countries difficult to identify.

- *Western industries are hampered in their scientific and technological co-operation with organisations from Central and Eastern Europe by the fact that, in particular, the legal situation (protection of industrial property rights) remains uncertain and that there is, in general a poor infrastructure.*
- *The countries of Central and Eastern Europe possess a pool of highly qualified researchers, who are able to adopt quickly to modern technologies. Unfortunately, however, they are primarily specialised in the fundamental sciences (mathematics, physics). The problem is to translate this fundamental know-how into products, and to exploit it to promote industrial competitiveness.*
- *Scientific and technological co-operation with Central and Eastern Europe can only be successful if there is a long-term commitment from the Western side, accompanied by high investments..*
- *Given the previous points, it is very unlikely that the involvement of industry in the EU programme on strengthening scientific and technological co-operation with Central and Eastern Europe will grow considerably."*

The IRDAC Round Table in Brussels, held in January 1995, as well as the EIRMA Annual Conference 1995, attended by R & D Directors from more than 120 industrial corporations from Europe, the US, Japan, India and Korea gathering for the first time in the 30 years history of the association in a country in Central Europe, i.e. in May 1995 in Prague, when debating the *„Global R & D Resources"*(12) reached the same conclusions: Sophisticated technology and the underlying sophisticated R & D is difficult to find in Central and Eastern Europe. Co-operation with those countries means heavy investments and a long-term commitment. For most industries (certainly for the smaller ones), this is outside their strategy since they have a short-term profit oriented view. For these reasons it is felt that in the countries of Central and Eastern Europe, profit from scientific and technological co-operation is still a very uncertain factor.
In sharp contrast to this, the same world-wide operating industrial corporations - regardless of their 'home-base'- are more and more obliged to have at least one, if not several, 'research laboratory antennas' in the United States and increasingly also in South East Asia.

2.22 Science

The Western scientific community has attempted to give assistance in various forms to the scientific community in Central and Eastern Europe: Intensified scientist-to-scientist working relations, twinning of institutes, bilateral and multilateral meetings by the Academies of Sciences leading in most of the cases to recommendations for action or real action. Special aid schemes have been deviced, i.e.by the European Union in December 1993 INTAS (International Association for the Promotion of Cooperation with Scientists from the Independant States of the former Soviet Union) with an original endowment of more than 20 Mill.ECU. There is also the *International Science Foundation for the Former Soviet Union (ISFFSU)* initiated by Georges Soros with an endowment of 100 Mill.US-$. As a joint initiative launched by the US, the EU, Japan and Canada an *International Science and Technology Center* was created in Moscow with a starting capital of 75 Mill.US-$. It was

meant to provide employment for high-level scientists previously active in the Soviet Nuclear and Military complex in order to prevent their 'Brain Drain' to other countries.
The European Union has enabled the countries of Central and Eastern Europe to use the funds from the largest EU aid programme, i.e. PHARE for almost any science and technology initiative seen as vital by the recipient country. Unfortunately, relatively few projects are funded through this mechanism since other sectors seem to have always higher priorities. In addition to PHARE there are several smaller funds earmarked for science and technology related concerns (TEMPUS, ACE, JEP, PECO, COPERNICUS and others.
The International Council of Scientific Unions (ICSU) in Paris has established a new committee in order to highlight this particular '***problématique'***, i.e. the *Special Committee on Science in the former Soviet Union and in Central and Eastern Europe* which has organised a series of meetings on the complex matter.(14) The last of these meetings, taking place in July 1996 in Paris addressed on of the most crucial issues, i.e. the question of the 'Financing of Basic Research in Central and Eastern Europe and the former Soviet Union' (15). Practically all intergovernmental organisations within the UN system or regionally operating intergovernmental agencies i.e. the Council of Europe, OECD, European Union as well as NATO have put the issue of Science and Technology in Central and Eastern Europe on their agenda. In addition to the international in-depth evaluation exercises of the Science System carried out in particular by the OECD and by UNESCO as well as by the initiatives of some of the Western governments, there all also a series of external evaluations mainly by Western Academies of Sciences. Norway, Sweden and Danmark respectively have undertaken such evaluation individually for each of the three Baltic states (*see chapter 2.4).*

Most recently, i.e. in summer 1996 the US National Science Foundation has undertaken investigation missions to the three Baltic States. Among their findings we find the following observations:

⇒ 'Perhaps most serious from the point of view of science, the Baltic States inherited very large and inefficient Soviet-style industries and institutes that were created to serve primarily the USSR'' needs, rather tan local ones.
⇒ Another problem is that the universities are largely devoid of research capabilities, which in the Soviet Union were centred in massive research institutes under the aegis of the Academy of Sciences.
⇒ A still further problem is the ageing research equipment and personnel...One example of this that the average age of scientists is quite high, reportedly 54 in Latvia, as older scientists tend to remain in institutes whereas many younger ones haft sought higher paying opportunities in the private sector or abroad.(13)

2.3 The assessment of the situation by observers from Central and Eastern Europe

This assessment of the situation, seen largely from a West European and from an American point of view, does in essence not differ from the point of view voiced by experts from the countries in Central and Eastern Europe themselves. In the recently published *„World Science Report 1996"* of UNESCO we read the following evaluation of the current state of science and technology in Central Europe made by a team of Polish experts: *„The system of 'real socialism' gave rise to a very large and generally inefficient research and development structure. This was represented mainly by vast networks of institutes and laboratories managed directly by the sectoral machinery of the centrally planned state economy. It succeeded in receiving a much larger share of the centrally allocated resources than did the system of the academies and higher education.*
The transformation processes of 1989-95 have served to reduce this legacy of 'real socialism': Something that could be seen as a positive phenomenon and as an unavoidable

verdict of history. There is, unfortunately, a very dangerous trend in that the liquidation of the old R&D system is also destroying many valuable elements of the old system that were not 'totally rotten'. What is more important is that this process of destruction is not being counterbalanced by the rapid creation of a new R&D system. Instead it is emerging very slowly because of the lack of coherent science and industrial policies designed and implemented since 1989, and a reluctance on the part of the new private entrepreneurship to promote research and development...
A third reason for the low creation of a new system is the reluctance of the transnational corporations and other foreign businesses to maintain and to develop R&D units in their enterprises in Central Europe."(16)

Talking about the situation in Russia, in his article entitled 'Russian Science: Snubbed and Sickly', *Sergei Kapitza,* President of Euro-Asian Physical Society observed: *„Fading respect, reduced funding, and the 'brain drain' have brought science in Russia to the vanishing point."(17)*

2.4 The situation of the Baltic states

In his contribution to the commemoration in 1992 of the 50th anniversary of the formation of the Soviet Union, the former President of the Academy of Sciences of the Republic of the Lithuanian SSR, *J.J.Matúlis,* after welcoming the liberation of his country 'from capitalist oppression' in 1940 recalled the state of the economy, culture and science in Lithuania prior to the restoration of Soviet power there' went on to say : *„...The bourgeois-fascist rulers did not care about science, which they regarded as luxury. One fascist Minister of Education even spoke publicly to the effect that science was the privilege of large countries, and small nations should not even dream of it. It was not surprising therefore that the bourgeois-fascist government did not support any real scientific research, and that the funds allocated for laboratory equipment and the purchase of literature and various materials were insufficient even to meet the need of teaching the students. The republic's industry was not interested in science either, for there was little attempt to improve quality or reduce cost prices..." (18)*

20 years later the Academy of Sciences has been changed into a honorary society of the Lithuanian and foreign scientists, which no longer administrates research. The Academy's Vice-President, *Eduardas Vilkas,* presented in 1993 the following assessment of the state of affairs: *„...The Lithuanian system of education and research is not well-positioned to serve national development needs. There are several causes for this. Most importantly, the research system, especially that of applied research, was designed to serve the needs of a highly centralised superpower. This, in turn, led to overspecialisation, rigidity, gaps in coverage and a high degree of militarization. Other factors are well known and common for most former communist countries: insufficient funds, and, as a consequence, a severe shortage of modern equipment; state and party administration of science; restricted access to world science; the separation of research from teaching; weak interest of the economy for technological change. Therefore, an average scientist and average research work were lower in quality than those in the West."* (19) According to *Eduardas Vilkas* scientific and technological research, most of which is concentrated in research institutes where the quality is sufficiently high, is in a different situation: *„The Lithuanian State, however, cannot produce reasonable funds for their existence"* Talking about the situation in Estonia. the then President of the Academy of Sciences *Arno Köörna* had this to say: *„In political and industrial spheres there is a strong tendency for supporting R&D which will produce short-term results. The reasons for this are*

economic difficulties and complicated tasks of transition from the old system to a new one. However, we are struggling to save basic science, which is a relatively high level in the Academy institutes and universities...“(20) His colleague from the Academy of Sciences in Latvia, *Janis Lielpeters* reached the same conclusions: *„The financial situation of science is made even worse by the fact that neither market nor state administration demands for the results of scientific investigation really exists in Latvia...“(21))*

The Nordic countries Denmark, Norway and Sweden have undertaken in the year 1992 on specific requests of the official representatives of the Science communities in Estonia, Latvia and Lithuania exhaustive evaluations of the Research systems in the three Baltic countries. For example, in the case of Latvia, the Danish Research Councils - based on reports, site visits and interviews - have created 19 expert panels which have presented detailed findings and recommendations in their respective fields of competence. *All the panels have noted a very serious economical crisis in the research system, as in other parts of the Latvian society. They stated that the available funding of research can now cover less than 50 % of what is considered necessary. Furthermore funding from the Latvian Science Council is only given for half a year at a time and covers all expenses incurred in a research project, including salaries, heating, electricity and the wohle infrastructure. This prevents planning of the research and provides no incentives for young scientists to remain in the research system. Neither do the low salaries in the universities and research institutes attract the bright young people to enter a scientific career.*
The findings from the in-depth evaluations carried out bilaterally by scientists from the three Nordic countries in the three Baltic countries do not basically differ from each other. The Danish evaluation of the situation in Latvia reached the following main conclusions, which are valid for the two other Baltic States as well:
„Even if the panels understand the very serious economic conditions in Latvia, they wish to point out that unless immediate measures are taken to ensure a stable funding of the research system, including salaries at a competitive level and funding of the infrastructure, the future existence of research in Latvia is endangered.
The panels are well aware that the solution of these problems may not be possible in the present economy in Latvia. It is therefore necessary to appeal to the international scientific community for assistance in overcoming this serious period of transition.
The panels wish to point out that there is a number of institutes in Latvia, which produce research of excellent or outstanding quality. Many of these institutes are now far too big for the needs of the Latvian society...
The international organisations, as for instance the EC, the UN-system and the Nordic Council of Ministers, could promote Latvian science by providing help in the international marketing of the research capacity and services which are available in Latvia...“(21a)

2.5 The brain drain

The ‘brain drain’, i.e. the national or international mobility of scientists and engineers is by itself an essential component of scientific and technological development. It has to admitted, however, that in comparison with Western industrialised countries the former socialist countries have been characterised by a certain ‘over-capacity’ of their scientific manpower. This high *manpower-intensity* aimed to compensate as far as possible for the low *capital-intensity in R&D* (i.e.deficits in scientific equipment and instruments) in the countries of Central and Eastern Europe. Under market economy conditions a reduction of the R&D population was, therefore, inevitable. The issue becomes alarming, when large segments of the scientific population of a given country are deciding or are being forced to emigrate from

their country of origin or - this comes almost to the same - if they have to leave their positions and enter unemployment or are obliged to accept positions which have no relation with their scientific skills (External and internal ‘brain drain’).
The restructuring of the economy in all socialist countries has led after 1989 to a crisis situation in their scientific and technological sectors. It is reported that in all countries the science population has been drastically reduced. Furthermore, the ‘image’ of a career in R&D seems to have lost its former glamour with the result that qualified young people seek their careers outside the world of Science and Technology.
Whereas in the publicly funded *scientific research* a number of support Programs have been devised by *bilateral governmental* and *non-governmental* initiatives and by intergovernmental organisations (22), the situation of the *industrial R&D system* of the Central and East European countries has been left to itself. Some general statistical data on the ‘brain drain’ of scientists in formerly government-funded research positions are available, but even less is known on the *exodus* of scientists and engineers formerly employed by industry. In any event, reliable data do not exist on either of the two fields (public research institutes and industrial research institutes).Some figures can demonstrate the dimension of the problem: Poland reports a ‘brain drain’ because of emigration and change of jobs, especially among young people, of 25 % of its scientific manpower.(23)
The East-West ‘brain drain’ of portions of the scientific community has to be seen in context with the ‘brain gain’, i.e. the migration of highly qualified managerial manpower (‘*skilled migration’)* into the countries of Central and Eastern Europe.(24))

2.5 Special case study: East Germany

The example of the integration of the former German Democratic Republic, a member state of the former COMECON, as from the 3. October 1990 into the Federal Republic of Germany is certainly not typical for the conditions of the integration of Central and Eastern Europe into the European Union. And yet, there are a number of consequences which should be carefully analysed by the Central and East European countries concerned, when preparing for the full membership in the EU. The East German experience is, rather telling for all other countries of the former COMECON:
In 1989 - according to statistics of the Ministry for Science and Technology of the former GDR - approximately 114.000 Scientists and Engineers were employed in industrial R & D of the GDR. When applying the criteria of the OECD ‘Frascati Manual’ on the definition of the R&D personnel perhaps the figure of 87.000 would qualify. Regardless of this definition, the fact of the matter is, that in the ‘year 7’ of the German reunification only 20 % of the industrial R & D staff of the former GDR is still employed. The East German share on the industrial R&D performance of the Federal Republic of Germany is presently appr. 2,4 % The costs for maintaining even at this drastically reduced level the East German R&D enterprise was mainly absorbed by governmental transfers amounting alone in the period of 1991-1995 to 4,5 Bill.DM and for 1996 to 1,26 Bill.DM.
What are the reasons for this dramatic collapse?

1. The Government-controlled Privatisation Agency (Treuhandanstalt) did not regard it as a mandate to introduce some sort of ‘structural policy’ in order to safeguard jobs or to maintain, even at a reduced level, the ‘Knowledge base’ of East Germany. Its main task was to form viable companies. Companies which were unable to produce a viable survival plan and could thus not be privatised had to be closed down. Socially acceptable solutions had to be found in these cases for the workforrce. Therefore, the Agency did not interfer with market forces not even than when it became obvious that industrial or R&D capacities of long-term strategic importance for the country as a whole were in danger to

disappear. The main concern of the 'Treuhandanstalt' has been *„to make the former state-run GDR economy with its vast and cumbersome enterprises competitive in the shortest possible time... This explains,* in the words of the Agency's former President, Ms. Birgit Breuel, *why the Treuhandanstalt operated on the basis of rapid privatisation, thorough restructuring, and, where it is inevitable, closure..."(25))* The German 'Treuhand approach' in privatisation is in sharp contrast to the 'Voucher privatisation' largely used e.g. in Lithuania. But vouchers do neither bring in fresh capital nor new technological know-how, which is badly needed for the modernisation of the country's industrial stock. It is not surprising, therefore, that President *Algirdas Brazauskas* of Lithuania expressed his dissatisfaction with the results achieved: *„We made a mistake when large industrial units were privatised for investment vouchers...(26)*

2. Most of the approximately 300 industrial 'Kombinats' (VEB's) of the former GDR have by now been privatised or closed. In total appr. 10.000 industrial enterprises of all sizes have been privatised. The capital of those enterprises which have survived is almost exclusively in the hands of West Germans or of Foreigners. East Germans did neither have the managerial skills to cope with the world-wide competition nor were they able to mobilise the necessary capital for the take-over and for the modernisation of the given enterprise. Even if they were in the position to meet somehow these requirements, they would find it very difficult to have access to the equally necessary technological *'know-how'*. In the experience of the German 'Treuhandanstalt' privatisation of former state-owned companies cannot mean 'a big increment in terms of revenue': *„The decisive 'profit' or benefit to be secured thereby is an innovative entrepreneur who is willing to invest in the company and make it competitive on his own account and under his own responsibility"(27)*
   The new owners of the drastically reduced industrial operations in the former GDR showed little interest in maintaining industrial R & D units in their East German subsidiaries. They argued that all the needed R&D results could be provided without any extra costs from their central laboratories in the West. (28) To compensate, at least partially, for this almost complete breakdown of the East German R&D system, the Federal Government has created some 15 to 20 Government funded scientific research institutions (Max Planck-Institutes, Institutes of the Fraunhofer Society etc.) which open some employment opportunities for scientists in the so-called 'New Länder'. Other highly qualified East German researchers have found employment in West Germany. But the majority of research staff remains unemployed or was able to find employment outside the field of scientific or industrial research.

As already said, the experiences of the transformation process of the East German economy and foremost the lessons to be learned from the privatisation of its industry cannot be compared to any other of the former COMECON countries. The re-unification of East and West Germany is a political challenge which had to be carried out regardless of the financial costs involved. The *annual* West-East-German transfer amounts to much more than 100 Bill. US-$ (ca. 160 Bill.DM), that is to say one hundred times more than the annual budget of UNDP.
For comparison: The famous 'Marshall-Plan', i.e. the European Recovery Program (ERP), has disbursed in the years 1948 - 1952 for all West European countries the total amount of 13,9 Bill.US-$. Allowing for inflation, the actual purchase power of the Marshall-Plan-Funds would be less than the annual West-East German transfer.
To give another illustration on the order of magnitude of funds required for the transition from centrally planned economies to market economies: In one of the rare existing estimates of the amount needed for the modernisation of the economy in Central and Eastern Europe, *Jacques Attali,* the first President of the European Bank for Reconstruction

and Development (EBRD) has advanced in 1991 the amount of 2.000 Bill.ECU. Roughly a quarter of this figure has already been transferred since 1990 from West Germany to East Germany alone.

Leaving these gigantic figures aside, the East German example allows, nevertheless, to draw some significant conclusions which may be relevant for other Central and East European countries eager to join the European Union:

- The industrial sector which looked competitive as part of COMECON practically collapsed after facing competition from the West. The East German share of the total industrial production of Germany as a whole is presently approximately 5 %. The East German share share on the total German exports in 1995 was 9%. The ‘balance of trade’ between the two parts of Germany shows a deficit of 200 Bill.DM p.a. in favour of West Germany.(29) Incidently, the same phenomenon can be witnessed in practically all Central and Eastern European countries in their balance of trade with the EU: Whereas in 1989 most of these countries had a small surplus in their trade relations with Western Europe, there is since 1991 an ever widening trade gap in favour of the EU. Germany alone has had in the the year 1995 a surplus of 3,5 Bill.DM in its trade relations with countries of Central and Eastern Europe. The East German exports to its former priviliged trade partners, i.e. the former COMECON countries went steadily down from nearly 30 Bill.DM in 1990 to less than 5 Bill.DM in 1995.

- The ‘knowledge system’ of the former GDR (Academy of Sciences and industrial research capacities) has been intensively evaluated by Western experts they have concluded that- with very few exceptions -it is generally in the best of cases only of marginal interest to the West.(30)
- The privatisation process has turned practically all of the emerging new private sector of East Germany into West German or foreign ownership
- East Germany with about 25% of the German population holds appr. 5 % of the private property of the country.(31)
- The official unemployment rate of East Germany is about 16 % as compared to 9 % in West Germany. If all the numerous governmental employment assistance measures would be accounted for, the unemployment rate of East Germany would be close to 25 %.(32)
- East Germany benefits, therefore, from the European Fund for Economic Eestructuring (EFRE) to the same degree as the least developed parts of the EU, i.e.Portugal, Spain, Greece, Southern Italy etc. For the years 1994-1999 140 Bill.ECU have been earmarked for the purpose by the EU.(33)

3. Industrial R&D and Science and Technology Policy

3.1 Interaction of Science and Technology Policy with other governmental policies

In the broadest strategic terms, governmental science and technology policy is intended to derive the maximum contributions from *scientific and technical resources* available to the government toward the achievement of a wide range of national goals, including national security, economic growth, public health, energy supply, environmental protection, and quality of life. While economic growth is the principal concern of *industrial research and development,* it is just one of many concerns for *science and technology policy of the government.(34)*

Science and Technology Policy embraces all concerns of the governments for the promotion of the nations technical vitality and competence, policies for allocating resources for research and technical education, and matters of management, organisation and institutional innovation.(35)
The role of government in supporting industrial innovation and in promoting a strong scientific and technological capability has thus become an important tenet of any national policy. Science and Technology policies inevitably intersect with major economic issues such as economic regulation, productivity, and public investment in innovation .

Talking about the present situation of governmental sectoral policies in this part of the world, *Antonin Kuklinski* of Poland had this to say: *„The art and wisdom of long-term policy making is very weakly applied in Central and Eastern Europe. There are no long-term economic policy, social policy, industrial policy, agricultural policy, educational policy, and so on. It is, therefore, not astonishing to find that a really comprehensive long-term Science and Technology Policy (STP) is also inexistent.*
It is extremely difficult, if possible at all, to formulate a comprehensive long term STP as an isolated phenomenon outside the general framework of policy making". (36)

3.2 The role of the government for policy making in Science and Technology

The objectives of the science and technology policy of the government are pursued along several directions, mainly by:
1. Strengthening the scientific and technical infrastructure of the country
2. Initiating programs to pursue specific goals
3. Improving the effectiveness of the scientific and technical system

Science and Technology policies can affect *the infrastructure* e.g.
- by influencing the quantity of graduates in science and technology,
- the balance of effort between basic research, applied research, development and engineering,
- the facilities and equipment to support R&D.

In practical terms, any legislation or government actions that affect these components of the technical infrastructure or 'Knowledge base' of a given country, even unintentionally shape science and technology policy.(37)

3.3 Science Policy *versus* Technology Policy?

The relationships among science, technology, innovation, research and development are fluid. They cannot always be clearly distinguished. What they have in common is, that they are all constituting the *'knowledge system'* or *'innovation system'* of a given country. „Science-based Technology" can be identified as „the major source of economic growth"(*Kuznets, **Modern Economic Growth, pp.9-10)***

„*Science policy*" is a relatively new phenomenon that emerged during the 1960s and is still in its formative stages. It can encompass both '*policy for science'* and '*science policy'* and '*science for government'(38).* It covers usually the entire spectrum from basic science and research until technological development.

In 1968 it was for the first time acknowledged, during the OECD debates on the *„technological gap"* between de Western Europe and the United States, that the ability to apply scientific discoveries for economic purposes is the most important single factor for the competitiveness of nations.
Consequently 'Science Policy' became in the 1970s 'Science and Technology Policy' and as such it is closely linked to both the industrial policies and the employment policies of nations.

The focus is gradually more on *Technology Policy* than on *Science Policy,* although the line between the two is not always definable. In the OECD countries science and technology policies are today increasingly part of the overall-strategy aimed at increasing competitiveness, hopefully without loosing sight of the equally important aspects 'quality of life' including the environmental issues. One of the key targets of any governmental science and technology policy is, therefore, the creation of the necessary environment for the interaction between science and technology and industry.

3.4Science and Technology Policy *versus* Research and Development Strategy

What is industrial research and development? In the exhaustive definition of ***Herbert I. Fusfeld,*** formerly President of the *Industrial Research Institute Inc.* in Washington D.C. it can be described in terms of the activities performed, and it can be measured in terms of the expenditures and personnel devoted to these activities. The uniqueness, the essence, of industrial research, however, is in its structure. All three aspects - activities, measures, and structure - are needed for the complete picture:
„Industrial research refers to all technical activities conducted within industry that are required to support existing businesses; develop and introduce new products, processes and services; and provide the basis for new businesses. Industrial research includes basic research, development, design, the building of prototypes, and when necessary for the development process, the operation of a pilot plant. It can include activity in those social sciences needed for the successful introduction of a new technology, such as economic analysis, market research, psychological and sociological studies, and even analyses in political science. Industrial research is a convenient and well accepted shorthand that includes the total range of activities within industry known as research and development or R&D".(39).
Whereas academic science is a language '*that knows no frontiers'*, and as such is almost a free good available to any interested party in the world, industrial Research and Development is financed by private or governmental national resources, and its results are used by States and enterprises whose mutual relations are based first and foremost on competition. International funding e.g. from EU or other intergovernmental resources is therefore giving financial support only to research activities which are called 'pre-competitive' or to consortia in which international teams of companies or institutes form task-limited consortia.

What is called for, is a better understanding of the legitimate competing interests of the government, representing the public at large (and thus pursuing long-term goals) and of industry which under the increasing pressures of global market forces has to pursue a R&D strategy aiming at essentially short-term objectives. For obvious reasons industry conducts R&D not to satisfy any intellectual curiosity but only to support its current business and to implement the company's growth strategy.
The required crucial close interaction between the two parts of the equation '*Science'* and '*Technology*' within the national '*Knowledge system'*, based on the experience of the OECD countries, can be demonstrated as follows:

„Technological development is only sustainable in the long term with the help of balanced efforts by the public and the private sector. If public R&D and in particular university research, are of a mediocre level, the long-term prospects of OECD economies may be endangered: The environment of firms deteriorates, investors are discouraged and the industrial fabric starts to weaken. But if public efforts are not followed up by private firms, the scientists trained in the universities will emigrate, and the research performed by public laboratories will be stifled or its results will be taken up and developed by firms abroad." (40))

3.5 National concerns in Science and Technology Policy

According to an UNESCO classification (41), the scientific and technological potential of any given country consists in essence of four elements, i.e. the country's:

1. *Human resources,*
2. *Financial resources,*
3. *Information resources,*
4. *Institutional resources.*

Science and Technology Policy is to a large extent conditioned by the *size of the country*:

- Compared to the United States each of the European research systems are considerably smaller. The Baltic countries belong not only to the smallest of the European countries, they are also in the middle of a deep political and economic transformation process. But even without this additional burden, it would be impossible for small and even for most medium-sized and for some of the larger countries to reach a critical size in all fields of scientific and technological endeavour. This forces them, to make choices between different research objectives and to define priorities. On the other hand it makes international cooperations a necessity.
- There are many examples in other small- or medium-sized countries demonstrating that good ideas and originality, based on the creativity of the individual, are not limited to empires or superpowers. The same, of course, can be said about the scientific creativity of small- and medium-sized companies in comparison to large TNC's. Any country that has a modern educational system and an infrastructure for science and technology can be scientifically 'fertile'. A country-by-country comparison of the 'National Science Indicators' using, for example, summary publications and citation counts of scientific papers published in international professional journals reveals to this effect rather surprising results. (42) Still, ideas are not enough. They do have to be transformed into technology , and even many small- and medium-sized countries in the West do not have an adequate R&D infrastructure for translating even some of their good scientific ideas into viable technology.(43) The so-called '*Green Book'* on 'Innovation' published recently by the European Commission reveals tremendous differences in the innovation performance of the EU member states.(44)
- The countries of Central and Eastern Europe will not be able in the foreseeable future to accumulate through their own efforts both the necessary capital and know-how to catch up with the scientific and technological expertise generated by Western countries. As a consequence, the national R&D system and technology policy will have to adjust to a system in which TNC's are accepted by the host country to be major actors. (52) At the same time, all efforts must be made by national governments to make sure that existing endogenous scientific and technological capacities cannot only survive but do receive priority political support for their modernisation.

3.6 International concerns in Science and Technology Policy

When presenting in 1993 its ‘White Book’ on *„Growth, Competitiveness, Employment - Challenges -The Challenges and Ways forward into the 21st Century“* The Commission of the EU has identified a number of serious deficiencies in the fields of Research and Technological Development. (46)

Among the various measures proposed to deal with this question we find proposals for better co-ordination of the R&D funds spent by member states. It was mentioned that only 13% of all public RTD resources (Research and Technological Development) are directed towards European co-operation in the context of ESA, CERN; EUREKA, the Community Framework programme etc. This means that the remainder, appr. 87% is managed and decided upon independently by the member states of the EU. It is reported that a similar amount being spent mainly by large European enterprises in industrial research and development. A need was felt for the EU member states to have regular exchanges of information on national policies in the field of RTD. Such an exercise might gradually lead to a convergence in the field of RTD policies. It was stressed, however *“that the national RTD policies of Member States are based on the specific needs of their industries and societies. For this reason, there always will remain differences between the national RTD policies of the Member States.“(47)*

An open question is, how the countries of Central and Eastern Europe which are already, among other equally important factors, separated by a still widening ‘technological gap’ from Western Europe, can actively participate in the streamlining process of Science and Technology of the EU countries.

It is for this reason that at an International Conference in Potsdam in 1993, initiated by the Council of Europe, on *‘Science and Technology Policy in the Service of the Greater Europe’*(48) it was proposed that in addition to the new science and technology policies of the countries in transition, to elaborate an >*All European Scientific Policy, determining priorities, and in particular including problem areas that cannot be solved by one country in Central and Eastern Europe alone*<. There was no illusion at the meeting as to the difficulties involved in such an undertaking: Since the Member States of the EU for the above mentioned reasons were not in a position to agree on a common unified policy on Science and Technology issues, the equally heterogeneous countries of Central and Eastern Europe would face even larger problems.

3.7 Regional and interregional concerns in Science and Technology Policy

Within the OECD countries - regardless of their size - Science and Technology became during the last decade an increasing strong force in regional development. The regionalisation of research systems is seen in the proliferating initiatives of universities and local or regional governments to develop and exploit the scientific and technological capabilities in their areas for purposes of economic growth, employment and the replacement of mature industries.(49)

On a world scale, regional groupings are also growing. The European Union together with its associated countries in Central and Eastern Europe are the most prominent example. The

Central European Free Trade Area (EFTA), initially launched by the four so-called Visegrad countries, and now open to other countries in the region, is the most recent example.
The question arises whether the participating countries prior to their intended joining of the EU would be ready to cooperate closely on a series of common priority issues, for example on Science and Technology matters. Recent experience shows, however, that the common past in COMECON leading to a politically imposed co-operation among these countries, seems to lead to unsurmountable '*mental blocks*'. *Antonin Kuklinski* furnishes an additional explanation. According to him the Visegrad countries find it difficult to overcome 'deep differences in historical trends experienced by the four nations, which have created different national characters and psychologies, and also different feelings of real or fictitious uniqueness.'(50)

As far as the Baltic co-operation is concerned, there seems to be in spite of the obvious advantages particularly on the field of science and technology a certain reluctance. Common strategic defence interests have most recently allowed to reach a common stand on NATO membership. There are also no differences on the common interests concerning a full membership in NATO, however on structural matters like the definition of common utilisation and harmonisation of the science and technology infrastructure, sensitivities seems to exist which are for the time being in the way of a common approach towards the needed restructure of their science system.(51) The former President of the Academy of Sciences of Estonia *Arno Köörna* proposed to this effect a 'common representation' of all three Baltic States in the EC coordinating body. He also felt that similar to Finland, Sweden and Norway (the two former countries were at that time not yet EU Member States) bilateral framework agreements relating to scientific and technological cooperation should also be concluded with the Baltic States.(52)

Reverting from the Baltic situation to the larger problem, i.e. intended integration of the two parts of Europe, in which regional development plays an increasingly important role, in this regard, it may be worthwhile to recall the findings of the Potsdam Conference in 1993 organised by the Council of Europe:

The development of harmonious economic and social relationships between the two parts of Europe in so far there are related to science and technology policy depends upon:

a) providing aid to reinforce and extend the scientific and technological infrastructure of the less developed or marginal regions;
b) providing a considerable increase in aid to science and technology programs directly concerns with regional development, whether these are carried out autonomously, in the region itself, or in the context of a collaborative program along existing lines, or in national laboratories;
c) examining the specific characteristics of the various regions of Europe in these respects;
d) evaluating the best long-term balance between policies for science and technology based on existing lines and policies developed from the enhancement of regional differentiation as a strategy.(53)

3.8 The role of the private sector

3.81 Local industry

In Western Europe it is reported that in average 58 % of all industrial enterprises undertake in one form or another industrial R&D. Even the very small enterprises (up to 50 employees) indicate that more than half of their innovations are generated from their in-house R&D activities. As larger the company is, their in-house R&D contributes overproportionally to the roots of their innovations: In large companies (more than 500 employees) 72 % of their new technical knowledge stems from their own R&D efforts.

External sources of information are without any exception of high importance for innovative enterprises. Universities and other external research institutes furnish informations to a lesser degree. The larger company, disposing over larger 'knowledge absorption capacities' than small and medium sized companies are able to benefit more from academic research than SME's.

Of high significance is furthermore technical know-how and scientific knowledge obtained from

- the parent companies of subsidiaries
- from the 'joint-venture'-partner
- from supplier companies
- from clients
- from public research institutes
- from technical analysis of other information sources (54)

It is highly recommended that the vast stock of information, statistical data, trend indicators, case studies etc. on R&D policy matters and on innovation strategies on the enterprise level which is available at practically no cost from the OECD and from the EU but also from other intergovernmental agencies as well as from international funding institutions is systematically being screened and adapted to the special requirements of companies in the 'countries of transition'.
The same has to be said about available information and guidance provided for example by the governments of the EU member states, by the US government and by others specially designed for the industry of the countries in question in order to assist them in fostering the innovation process. Since there are not any longer 'national solutions' and 'national recipes' possible, those countries in Central and Eastern Europe can easily benefit from the experiences gained in Western Europe and in other industrialised countries of the world.

Specifically on the enterprise level, companies in Central and Eastern Europe should have all interest to 'plug' into the *knowledge pool* provided by organisations like the *European Industrial Research Management Association* (EIRMA) in Paris, which groups more than 180 research-intensive companies from practically all West European countries . It is deplorable that there is still no member in this organisation from East Germany or from any of the Central and East European countries. EIRMA has been created in 1966 under the auspices of the OECD in Paris as one of the possible answers to close the at that time widely debated *'technological gap'* between Western Europe and the United States. EIRMA has been modelled after the successful and prestigious *Industrial Research Institute* (I.R.I.) with its headquarters in Washington D.C.. I.R.I. has more than 250 US industrial corporations as members. Similar organisations have been created in Japan, Australia, Canada and in South Korea. These organisations constitute a permanent world-wide non-governmental mechanism for the exchange of experience (and, of course, for personal contacts) among the members of these organisations. This international network on the enterprise level is available to interested industrial companies in the countries of Central and Eastern Europe and can assist them in accelerating their integration into the 'global system'.

Within the framework of the EU there are also numerous industry-oriented advisory committees and associations which produce information of high relevance to companies in Central and Eastern Europe.(55)

Since foreign companies, if they can be attracted at all to invest in Central and Eastern Europe, are reluctant to install in addition to industrial plants costly Research and Development facilities, it is fatal what the former Minister of Science of Poland, *Witold Karczewski*, revealed at a recent International Symposium of the German-American Academic Council Foundation: „*Our private sector is not yet ready to sponsor Research and Development*“.(56) *Eduardas Vilkas* reports about the same dilemma in Lithuania: „*...Prospects to get support for applied research from industry are poor, if not hopeless, because of the poor situation of industry itself.*“(57)

Local companies in Central and Eastern Europe - provided they would dispose over the necessary financial facilities - could, of course, instead of generating costly and time-consuming their own technological know-how, procure any foreign technology they wish in order to modernise their production facilities and their production lines. Western companies may be interested in this type of proceedings because of the following reasons (Baranson):

⇒ The decision to release corporate assets, like technology, that have traditionally been considered as of the highest proprietary value is part of a larger and more comprehensive new logistic of both national or transnational companies as a direct means to earn additional returns.

⇒ The sharing of highly sophisticated, proprietary know-how with a foreign enterprise - either through a joint-venture or through licensing arrangements - is often done to offset the enormity of R&D or production tooling expenditures, or to circumvent non-tariff barriers.

⇒ Western companies may also be interested in what may be called ‘measured release of core technology’. This is most common within the process design and engineering industry where the company is interested in selling newly designed technology as extensively as it can and reinvests a portion of profits in developing new generations of technology. In most cases a deliberate attempt is made to retain an essential element of the know-how, without which the purchasing enterprise is unable to develop a more competitive version or to become self-sufficient in the technology.

⇒ Finally, a Western company may be willing sell technological assets that are not considered to be central to the company’s business or no longer commercially viable.

In the global trade of technology there is always the danger for the seller that a technically strong and commercially astute foreign purchaser may pre-empt third-country markets, or second-generation R&D by the foreign enterprise may result in the creation of a new aggressive competitor.(58)

But even assuming it would be possible to import the necessary ‘Know-how’, it cannot be too strongly stressed that without a minimum of company in-house R&D efforts industrial enterprises will not be able to benefit from R&D results produced abroad. It is for this reason that the decline of the scientific and technological capabilities of the Central and East European countries may soon reach proportions which may make them unfit to become equal partners within the global ‘knowledge-based’ industrial competition. The other option would be, as the case of the transformation of the industrial base in East Germany has demonstrated, that the key industries of the ‘countries in transition’ will either disappear under strong foreign competition or will be to a large extent under foreign domination. This may be in the interest of job security not necessarily negative. The free movement of capital within the countries of the European Union is, after all, one of the most important political achievements of the treaties of Rome (Chapter 4, Article 67). If carried too far, it will inevitably create tremendous social tensions.

3.82 Transnational corporations

It has long been recognised that private direct investment through the transnational corporation is unique in providing from a single source a package of critical industrial inputs: capital, technology, managerial skills and other services necessary for production and distribution. TNC's do not undertake major innovative research without visible prospects of a substantial market - unless they are subsidised. The bulk of R&D financed by the TNC's is done by the parent organisation or in the home country of the parent organisation.(48) Many internationally operating companies see no need for the allocation of funds for international R&D because their domestic R&D programs generate products that can be produced and sold abroad as well as at home.(59)

Jon Sigurdson of Lund in his essay on 'The Trans-National Corporations (TNC's) in former socialist planned economies' brings this strategy to 'the point'.: He says *„the question arises to what extent and in which areas have foreign actors an interest to utilise and expand the domestic R&D structures?* (60). Many TNC's have shifted away from previous strategies of transferring a complete, fully functional business including a R&D facility to a foreign market (61). The necessary 'Internationalisation' of the R&D organisation of TNC's can today be easily achieved without geographic decentralisation. One of the often practised models is called '*centralised internationalisation':* that is," the development of systems and procedures to raise the sensitivity of the centralised R&D function to markets, competitors, and sources of technology outside the home base."(62) In the experience of *Siemens,* globalisation of production has been the driving force for globalising R&D. 12.000 out of the total 47.000 R&D staff of Siemens are occupied outside Germany.(63) The IRDAC Roundtable mentioned earlier confirmed this observation as follows: *„Scientific and technological cooperation with Central and Eastern Europe can only be successful if there is a long-term commitment from the western side, accompanied by high investments."(64)* Similar is the experience of the *Daimler-Benz group:* 'Foreign investments are a precondition for the sustainable improvement of the economy (including the R&D sector). Such investments, however, need governmentally guaranteed security conditions."(65) Therefore, *Jon Sigurdson* is probably right when he predicts that the existing R&D structures in Central or East European host countries will only play a marginal role in the newly established subsidiaries of joint ventures. As a more fundamental reasoning, not only valid in the special situation of Central and East European countries, he argues that the acquired enterprise units have initially to be integrated into the global networks of TNC's because R&D is generally conceived to belong to the core competence of TNC's, that should be tightly controlled, while the utilisation of engineering talent can easily be tapped and substituted for high cost engineers in West Europe.(66) Another aspect, equally not applicable alone to Central and Eastern countries, but of importance for any 'host country' dealing with TNC's, has been highlighted by *Alexander Keynan* of Jerusalem: He underlines that International co-operation in industrial technology is generally a complicated matter, especially if co-operation is to be carried out between industries owned by TNC's located in different countries. The government of the host country tries (not always successfully) to assure that it benefits from industrial research done in its country.(67)

4 Conclusions and Recommendations for Future Action

when preparing for the adherence of the countries of Central and Eastern Europe as full members of the EU, the issues concerning the inequality of their science and technological systems with Western standards do not seem to get sufficient attention.

- The performance of basic research in the former COMECON countries is regarded as rather strong. In the past, the absence of market forces and the unknown fierce competition among enterprises the translation of the results of fundamental research into elements of the innovation chain - leading ultimately not only to new scientific knowledge, but also to new technological products - hardly took place. The industrial spin-off from results in military and space research to civil applications, for many years one of the most important sources of technological innovations in Western countries, was practically unknown.
- The severe economic reforms which all Central and East European countries are facing have had already serious consequences for the viability of the R&D sytems of these countries. This will inevitably have a negative long-term impact on the economic take-off so badly needed in Central and Eastern Europe. An ICSU workshop on the financing of basic research in Central and Eastern Europe held in Paris in July 1996 and attended by high-level representatives from 16 Central and East European countries reached the conclusion: *„In general, the governments consider basic research <a needless luxury>...Participants noted with concern the general trend of their governments to pressure for the expenditure of limited financial resources on applied research, where results can be more quickly demonstrated, rather than on basic research.“(68)*
- Since neither government nor the private sector can mobilise the necessary financial sources to preserve, even at a reduced level, a viable ‘Knowledge system’ during the period of transition which Eastern Europe is going through, ‘awareness raising efforts’ efforts should be made by the international community. The governments concerned should realise that their entry conditions into the European Union will become even more difficult if their most important asset, i.e the .highly qualified manpower within the national research systems, has been dispersed. The State Committee for Scientific Research of Poland has thus rightly observed: *„The system Science-Technology-Economy should be recognised as the leading element in the development of Central Europe and its integration with the European Union.“(69)*
- One of the strongest arguments in the increasingly heated debate on the opening of the European Union for interested countries in Central and Eastern Europe is the expectation that these countries will be belong to the fastest growing markets for technology in the years to come. All of them do have presently a huge demand in modern technology but do not dispose of the necessary purchase power. But unlike many developing nations of the still so-called ‘Third World’ they dispose of a large potential of qualified scientists and engineers as well of skilled manpower and this is, after all, the most precious global resource.
- What seems to be called for is a series of measures aiming to mobilise the still considerable scientific and technological assets of the countries of Central and Eastern Europe within the framework of the emerging market economic system. Of equal importance is a set of measures seeking to link the new national R&D systems on all levels with the R&D of the Western countries.
- The most important political decision to be taken by governments concerns the funding of the science and technology base of the country. In average, the West European countries are spending more than 2% of their GDP on R&D. Within the EU of the 12 in average 0,92% of the BIP is being spent on R&D (1992) The countries of central and Eastern Europe, operating on a much lower GDP level in absolute terms, should aim at a target

which is not much lower than that. The basic research sector should have an identifiable considerable portion of the total R&D funding, i.e 1.0 to 1.5% of their individual GDP. (70)

- The governments have also to decide on the ratio ***Basic Research- Applied Research-Development.*** Japan, for instance, spends only 12,6% of its R&D budget on basic research, the US 14,6 and the European countries Germany and France 19,8% and 20,3% respectively.
- Within the expenditures on Industrial R&D there are marked differences between the OECD countries. The 15 countries of the EU have obtained in average 13,5% of their total industrial R&D expenditures in form of government subsidies. The US: 29,3%, France 19,5%, UK 14,8%, Germany 8,4%. These figures demonstrate the interaction of governmental oriented industrial policies with the orientation of the R&D performance of the private sector. In addition to this there is a whole series of governmental instruments to subsidise the manufacturing sector and to influence R&D: Subventions, interest-reduced loans, ***government securities,*** government joint ventures, tax incentives, mixed forms of some or all of them. (71)
- Another important factor of the national 'Knowledge base' is the location of the R&D Scientists: In the United States almost 80% of the R&D staff is employed by the private sector, in Japan nearly 40% and in the European Union (average) some 25%.
- Integration within the knowledge-transfer system of the OECD countries.
- Screening achievements in the basic sciences and linking them with market-related mechanisms.
- Participation in the traditional multilateral intergovernmental programs of the EU, such as EUREKA or COST, as well as in the newly launched special EU R&D multi-country programmes, such as 'The Phare R & D Networking" DANTE (Delivery of Advanced Network Technology to Europe), „The Phare ACE Programme (Action for Co-operation in the field of Economics), R&D Networking: COSINE (Co-operation for Open System International Networking in Europe).

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