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Science in formerly socialist countries: Asset or liability within new societal conditions?

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– Discussion Paper –**

P 02-401

**Science in Formerly Socialist Countries –
Asset or Liability within New Societal Conditions?**

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Abstract

Knowledge and learning are seen as key success factors for international competitiveness and economic growth in contemporary societies and have been placed at the top of the policy agenda in many countries. But actual developments in former socialist countries of Europe and Asia have totally run counter to such aims in the last decade. Science and technology (S&T) in the transformation countries have undergone major changes on all planes, as simultaneously institutional corrections within the S&T system have taken place and the systemic changeover in the political and economic fields has also effected major changes to the size, structure and content of the domestic demand for scientific results and services, and in addition to that, the international opening-up to high-tech imports and other forms of technology transfer has further minimised the need for domestic R&D.

Despite big shifts in the spectrum of scientific activities, only partial devaluation of knowledge and skills has taken place, and experience in research has actually proved invaluable in coping with new tasks inside and outside of scientific institutes. But, the inherited institutional preconditions in science and research, along with individual knowledge and levels of educational attainment are not assets and advantages in and of themselves. They must constantly be seen in relation to the overall societal framework. Indeed, the problem seems to be one of how to employ, change and utilise the personnel and other capacities inherited from the socialist era, with the abilities, skills, experiences etc. that it has, in such a way that it is able to meet the new demands, to cope with the challenges and to act as an asset under conditions of globalisation.

Zusammenfassung

Wissen und Lernen werden als Erfolgsfaktoren für internationale Wettbewerbsfähigkeit und Wirtschaftswachstum in modernen Gesellschaften angesehen und nehmen einen Spitzenplatz in der Politik vieler Länder ein. Die tatsächliche Entwicklung in den früher sozialistischen Ländern Europas und Asiens ist jedoch im letzten Jahrzehnt völlig entgegengesetzt verlaufen. Wissenschaft und Technik (W&T) der Transformationsländer haben vielfältige Veränderungen erfahren, da neben institutionellen Korrekturen in W&T der Systemwandel in Politik und Wirtschaft auch Umfang, Struktur und Inhalt der Nachfrage nach wissenschaftlichen Ergebnissen und Leistungen wesentlich verändert hat. Zusätzlich hat die internationale Öffnung für high-tech Importe und Technologietransfer den Bedarf an einheimischer FuE weiter schrumpfen lassen.

Trotz der erheblichen Verschiebungen im Spektrum wissenschaftlicher Aktivitäten sind Kenntnisse und Fähigkeiten nur teilweise entwertet worden; Forschungserfahrungen waren vielmehr vorteilhaft für die Bewältigung neuer Aufgaben innerhalb und außerhalb der Wissenschaft. Jedoch sind vorhandene Institutionen in Wissenschaft und Forschung sowie individuelles Können und Qualifikationen nicht an und für sich günstige Voraussetzungen und von Vorteil. Sie müssen immer in das jeweilige gesellschaftliche Umfeld eingeordnet werden. In Wirklichkeit besteht das Problem also darin, die aus der sozialistischen Ära übernommenen Kapazitäten und insbesondere das Personal mit seinen Fähigkeiten, Fertigkeiten und Erfahrungen so einzusetzen, anzupassen und zu nutzen, dass es den neuen Anforderungen entspricht, sich den Herausforderungen stellt und so tatsächlich als ein Aktivposten unter den Bedingungen der Globalisierung wirksam wird.

Content

1.	Introduction – the Problem.....	1
2.	Changes in S&T during the 1990s – Facts and Figures	5
2.1	The Dismantlement of R&D Resources as the Dominant Trend.....	5
2.2	Comparative Analysis of R&D Personnel Changes in the CEECs in the 1990s	9
3.	Institutional Transformation of National S&T Systems	18
3.1	Three Phases in the Institutional Transformation	18
3.2	The Decisive Influence of Political and Economic Factors on Changes within S&T	24
4.	Résumé and Conclusions.....	30
4.1	Substantial preservation of R&D capacities or dismantlement as a consequence of ‘insufficient quality’?.....	30
4.2	Is science a necessary prerequisite for the transformation of society and a new economic upturn?	31
4.3	Are needs for science and research changing and leading to devaluation of the skills and experience of scientists?	33
4.4	Summary	36
	References	39

List of Tables and Figures

Tables

- 1 CEECs: Trends in R&D intensity: GERD/GDP
- 2 Number of post-graduate students by scientific fields in Belarus

Figures

- 1 CEECs: General trends in R&D personnel
- 2 S&T Personnel in Vietnam
- 3 East Germany: Methodological and real changes in R&D personnel
- 4 R&D personnel by sectors in Romania
- 5 Hungary: Scientists and engineers in R&D institutions
- 6 Development of Universities in Vietnam
- 7 Publication activity (SCI) of selected CEECs
- 8 Publication activity (SCI) of European CIS countries
- 9 Age structure of scientists in Lithuania
- 10 Levels of dissolution and fragmentation of the former socialist S&T system
- 11 Three-phase model of institutional transformation of STS
- 12 Comparison of R&D structures in West and East Germany

1. Introduction – the Problem

Science and research, or in a wider sense, knowledge and learning are seen as key success factors for international competitiveness and economic growth in contemporary societies. Therefore, knowledge-related goals and measures have been placed at the top of the policy agenda in many countries.

Representatives of the USA published the important documents ‘Science in the National Interest’ (1994) and ‘Unlocking our Future: Toward a New National Science Policy’ (1998) emphasising that the USA must maintain and improve its pre-eminent position in science and technology in service to society in a changing economic, political and social context (cf. NSB, 2000, pp.1-22,1-23). South Korea implemented 1992 the ‘Highly Advanced Nation (HAN) Project’ with the aim to fortify basic and product technologies, especially in the area of high-tech, in order to catch up with the highly industrialised states by the beginning of the new millennium and increased its research and experimental development (R&D) intensity to an international top level (OECD, 1996). The European Union (EU) too pursues within the so-called ‘Lisbon Strategy’ the objective of making the EU by 2010 “the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion” and of developing to that end, in conjunction with several other measures, a ‘European Research Area’ based on pan-European scientific collaboration (EC, 2001). Spain, currently holding the presidency of the EU, is promoting its concept of a ‘European Research and Innovation Area’ alongside the Sixth Framework Programme (Euroabstracts, 2002). In this way the EU is reacting to the widening of the gaps in technology, research and innovation between the EU and the US, but also to developmental disparities between EU members, which have appeared in recent years (EC 2001a). Not the least of its aims is to cope successfully, in science and technology (S&T) as in other fields, with the intended acceptance and integration of 10 and more new members, most of them former socialist Central and East European countries (CEECs) (cf. Weber et al., 1999).

But actual developments in former socialist countries of Europe and Asia have totally run counter to such aims in the last decade. Systemic transformation has subjected the science and technology systems (STS) of those countries not only to institutional changes, but also to a sharp decline, to dissolution and fragmentation (cf. Meske, 2000; Meske et al., 1998; Mindeli and Nadiraschwili, 1997; Mayntz et al., 1995; Balasz et al., 1995). The social prestige of

science and technology has deteriorated and the reduction of R&D capacities has been so extensive that the role of science and research in these countries has been placed in jeopardy. However, there were sharp differences of opinion as to the causes and possible consequences of this disruption, and about the conclusions that needed to be drawn by actors in the political, economic and scientific spheres. The spectrum of viewpoints on these matters ranged between two poles: On the one hand there were those, including most scientists in these particular countries, who regarded the relatively extensive educational and scientific capacities that were built up in the socialist era as some of the most important resources for the successful management of the necessary social transformations, and especially for the strengthening of the given country's international competitiveness through its own innovative activity¹. The capacities should therefore, in this view, be preserved and further utilised as much as possible, but also be restructured and modernised as much as necessary².

This engenders a controversy with those who question whether these capacities should truly be regarded as genuine resources. The most extreme argument to be advanced was that sciences in the (former) socialist countries were (or had been) of such low quality that they did not really constitute a genuine 'potential', or that their further utilisation was only to a limited extent feasible³. Other representatives did not question in such a categorical way the quality of science in these countries, yet they did express major doubts as to their future role and likely utilisation. The argument put forth here was that new social circumstances have heavily devalued individual experience and qualifications and also fundamentally changed the demands that society places on education and research. For that reason, they contend, the

¹ As for the GDR, such considerations, computations and development scenarios for its science and research were described in their various aspects as early as 1990 (cp. Meyer, 1990).

² "Russia is faced by a dilemma in becoming part of the international S&T community where results and performance determine success: preserving the potential of the enormous S&T establishment (which may, in truth, be too large for its own good), while attempting to become more efficient and productive by rationalizing and letting the market determine what is needed" (Schneider, 1994, p. 213)

³ This argument had a significant role to play, especially in 1990 prior to the accession of the GDR into the FRG, but also from that time on in proposals concerning the transformation and renovation of science in other former socialist countries. Prof. Zacher, president of the renowned Max-Planck-Gesellschaft, for example, spoke to this effect when he referred to a „research desert in the GDR“ (Frankfurter Allgemeine Zeitung no. 141 of June 21, 1990, p. 31), notably in the humanities and social sciences, while other West German researchers stated that „the quality of GDR sciences is generally very low, even in comparison to other countries of the Eastern block, which has something to do with the fact that in the natural sciences at least, as physicist Harald Fritsch of the University of Munich puts it, at least 85% of all professors were either members of the SED or covertly working for the Stasi [State Security]“ (quoted in Süddeutsche Zeitung no. 152 of July 5, 1990, p. 48)

capacities inherited from the old system are either qualitatively inadequate and/or oversized; they therefore not only could, but must be reduced. Such critical views were widespread in Western countries and had also been adopted – for a wide variety of motives – by indigenous political and entrepreneurial actors (for example, in Russia, cf. Gokhberg, 1996, p. 2).

These different views and arguments had by the beginning of the 90's already led to controversies about the proper approach to the transformation of science. For example, recommendations made by OECD experts who called for the complete reorganisation of the R&D system of Czechoslovakia tended to encounter scepticism on the part of the Czechs and Slovaks

“as to the viability or the feasibility of implementing the institutional and structural changes proposed by the (western OECD-) Examiners. Whether they were sceptical to the short-term effectiveness of the changes or of the viability of the more long-term perception of the evolution of the S&T sector remained unclear. A second area of disagreement between the Examiners and their Czech and Slovak colleagues appeared to be the latter's belief that existing institutions could be modified or provided with better incentives, and that, given these, they could fulfil new functions, achieve higher levels of efficiency and make effective contributions to a market economy. Finally, there seemed to be a view among the Czechoslovak participants that weak S&T institutions – the universities and the private industry sector – would somehow be strengthened and improved without the elimination or radical down-sizing of existing S&T institutions” (OECD 1992, p. 186).

Today we possess more than 10 years of experience with the transformation and renovation of science in the former socialist countries. That gives us the opportunity to critically assess both the arguments that were advanced at that time and the measures and the consequences pertaining to the role of science and research in modern societies that were then drawn from those arguments. Such a critical examination is interesting, not only in immediate practical terms, but also from a theoretical point of view concerning the relationship between science and society. One of the open questions is also whether, in the light of the experience of former socialist countries, science and scientific knowledge is truly to be seen as an asset, i.e. a valuable resource, for future development – regardless of fundamental social changes – or as just one more structural problem, i.e. a liability, to be dealt with along with political and economic transformations.

One prerequisite to answering this question is a thorough analysis of the changes that have occurred to date and their foreseeable consequences. A number of considerations that are pertinent to this topic shall be presented here, based on studies in East Germany, Central and

East European countries and Vietnam before and during transformation (cf. in particular Meske, 1990, 1993 and 1998; Meske et al., 1998; Meske and Dang Duy Thinh, 2000).

2. Changes in S&T during the 1990s – Facts and Figures⁴

2.1 *The Dismantlement of R&D Resources as the Dominant Trend*

A preliminary overview of quantitative changes within S&T in the transformation countries of Central and Eastern Europe and in Asia evidences a pattern with quite uniform basic tendencies, a pattern of rapid and pronounced absolute and relative reduction of scientific resources, especially of resources that are assigned to R&D.

Considering that for a variety of reasons the data on financial expenditure for science in most countries is hardly comparable on a long-term basis, changes in R&D intensity, the measure of the ratio of Gross Expenditure on R&D (GERD) to Gross Domestic Product (GDP) shall serve here to provide a preliminary overview (cf. Tab. 1). According to such data, R&D intensity has fallen to between 10% and 60% of its pre-transformation level (with only Slovenia and the FR of Yugoslavia maintaining a level of around 70-75%, which represents a more minor decline). If it is considered that GDP itself, to which R&D is being related, had also suffered a clear decline in all of these countries and has with few exceptions (Poland, Slovenia, Hungary for example) not yet recovered its initial level (EBRD, 2000), the aforementioned percentages may be taken to represent the boundaries of the resources that remain to R&D.

As financial indicators are subject to a wide variety of influences, it is changes in R&D personnel levels that we hold to be the most adequate particular measure of macro- and meso-structural changes. Although these too have certain limitations with respect to their exactitude, there is a relatively clear basic trend of R&D personnel reduction in the CEECs and in Vietnam (and also in China, cf. Yang, 1998, p. 158), which is – much like the changes in R&D intensity that have been referred to – characterized by a cutback to less than 40% of its former level in most of these countries in just a few years (cp. Fig. 1 and 2).

⁴ The information provided in this and in the following section is derived from analyses of the development of science and technology in the transformation countries, which have been performed over a period of many years, often in collaboration with authors in the countries in question. The main results of these analyses are presently being prepared for publication in a book “S&T in Eastern Europe at the Turn from the 20th to 21st Century – from System Transformation to European Integration” (ed. W. Meske, CEU Press Budapest, forthcoming), including chapters on Belarus (Nesvetailov and Slonimski, 2001), Bulgaria (Simeonova, 2001), Czech Republic (Müller, 2001), Estonia (Martinson, 2001), Hungary (Mosoni-Fried, 2001), Latvia (Kristapsons, 2001), Lithuania (Dagyte, 2001), Poland (Kozłowski, 2001), Romania (Sandu, 2001), Russia (Gaponenko, 2001), Slovakia (Zajac, 2001), Slovenia (Stanovnik, 2001), Ukraine (Kavunenko, 2001), FR Yugoslavia (Kutlaca, 2001).

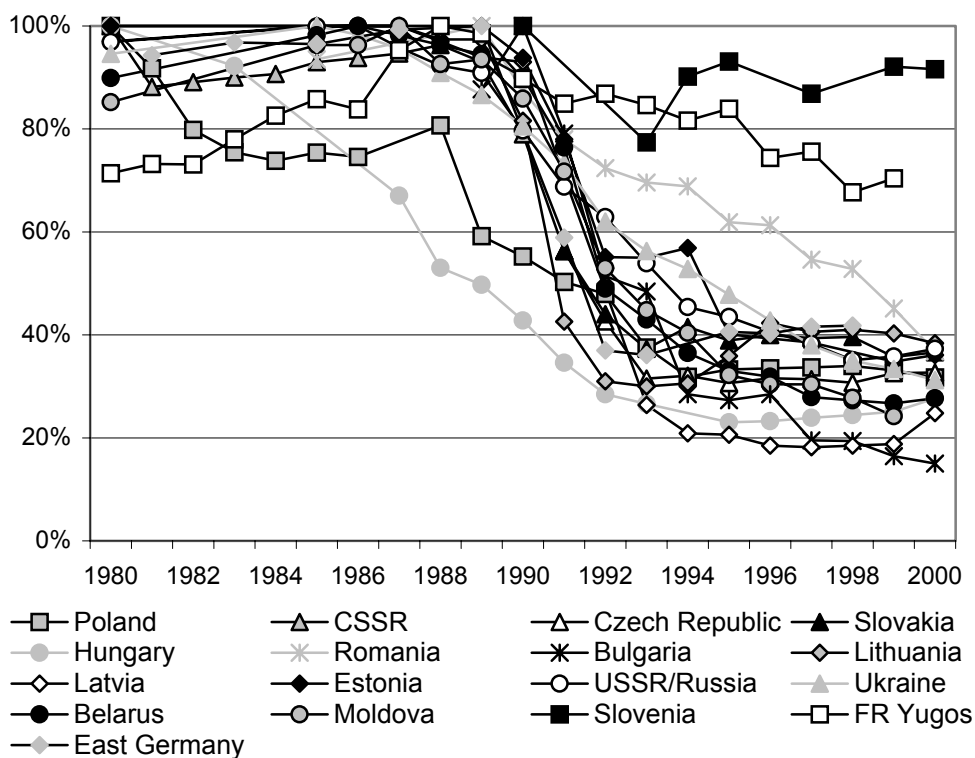
Table 1: CEECs: Trends in R&D intensity: GERD/GDP (%)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Relations of min. and max. values, %
Russia		2.03	1.43	0.74	0.77	0.84	0.79	0.90	0.99	0.93	1.06	1.09	36
Ukraine	3.10	2.50	2.50	1.60	0.70	0.60	0.60	0.50	0.50	0.40	0.40	0.30	10
Belarus		2.27	1.43	0.82	0.78	0.80	0.89	0.88	0.85	0.82	1.09	0.82	34
Estonia	1.30	1.10	0.60	0.40			0.63	0.60	0.60	0.61	0.76	0.70	31
Latvia		1.60			0.48	0.42	0.52	0.46	0.43	0.45	0.42	0.48	26
Lithuania	(0.5-0.6)*				0.35	0.52	0.48	0.52	0.57	0.57	0.52	0.60*	58
Poland	0.90	1.10	0.60	0.84	0.87	0.82	0.74	0.76	0.76	0.72	0.75	0.58	53
Czech Republic	4.08	2.14	2.02	1.71	1.22	1.13	1.04	1.08	1.18	1.28	1.25	1.37	25
Slovakia	3.88	1.75	2.25	1.88	1.53	0.96	0.98	0.97	1.13	0.82	0.68	0.69	18
Hungary	1.96	1.61	1.09	1.08	1.00	0.93	0.75	0.67	0.74	0.70	0.70	0.82	34
Romania	2.60				0.82	0.68	0.80	0.71	0.58	0.49	0.41	0.37*	14
Bulgaria	2.63	2.38	1.53	1.64	1.18	0.88	0.62	0.52	0.52	0.59	0.59	0.55	20
FR Yugoslavia	0.84	1.11	1.15	1.20	0.86	1.17	1.11	1.26	1.29	1.24	1.40		72
Slovenia		1.80	1.00	1.90	1.60	1.77	1.71	1.44	1.42	1.48	1.50		75

*provisional/estimated data; = max., = min.

Source: Own compilation based on national statistics and country reports.

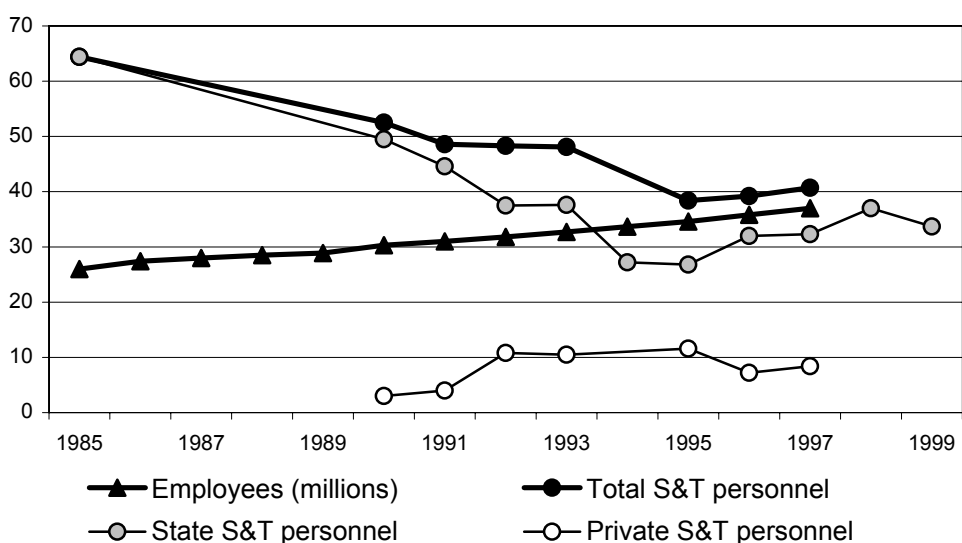
Figure 1: CEECs: General trends in R&D personnel



Source: Own compilation based on national statistics and country reports.

Methodological note: The highest value in the time series for each country has been set at 100 per cent. These time series merely indicate trends and are not based in all countries on a consistently uniform time series. In the case of breaks in the statistics as a result of changes in the data collection methodology, the changes have been extrapolated using the percentage changes rather than the absolute data.

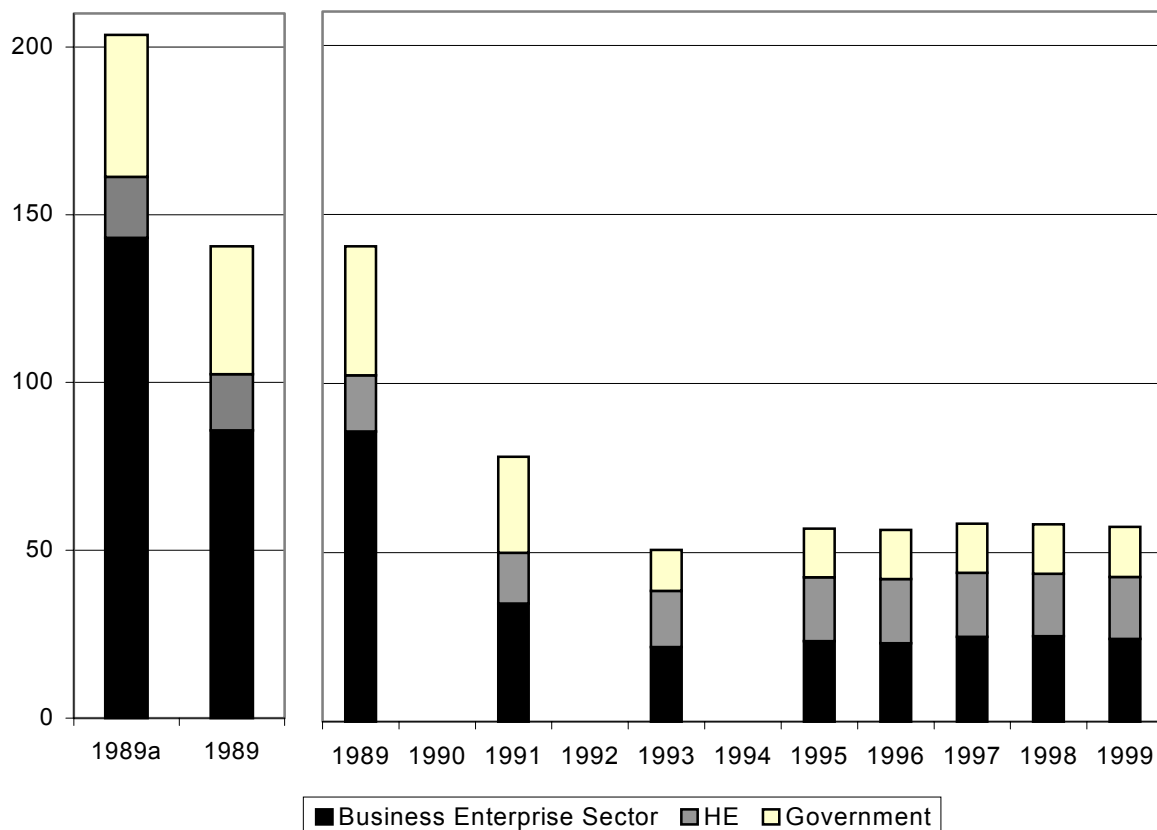
Figure 2: S&T Personnel in Vietnam



Source: Own compilation based on data from the Statistical Yearbooks of the Socialist Republic of Vietnam, Hanoi (cf. Meske, 2000a, Fig. 4.4)

The magnitude of the reductions is accurately stated, even when due consideration is given to the major changes that were made in the course of the 90s to the methodology applied in these countries to collect and properly attribute statistical data on science and R&D. There is a tendency for the once not very uniform R&D statistics for the CEECs (cp. Meske, 1990) to fall into line more and more with the measurement of scientific and technological activities in accordance with the „Frascati Manual 1993“ (OECD, 1994), which is standard in the OECD countries and generally more strictly defined. But because the curves in Fig. 1 (cp. the methodological note contained therein) do not in each case show the absolute change, but rather, extrapolate the percentage changes where structural ruptures have taken place, the changes in methodology have affected the shape of the curve only slightly. This view is also confirmed by the changes in East German R&D personnel, which in this respect can be confirmed and itemized differentially (cp. Fig. 3).

Figure 3: East Germany: Methodological and real changes in R&D personnel (1 000 FTE)



1989a: Statistics of the GDR; all other Data according to OECD-Methodology
 Source: Own compilation, based on Stifterverband, 1990; BMBF, 2002, p. 427.

At the beginning of 1990, acting on a suggestion made by the ‘Stifterverband’, a recalculation of the GDR R&D statistics (for expenditure and personnel) in accordance with OECD methodology was undertaken, making use of detailed primary documents (cp. Stifterverband, 1990). As a result, the changes that have been effected here since 1989 can generally be broken down accurately, distinguishing between changes attributable to methodology and the real changes that took place starting in 1990. The GDR’s R&D personnel, when calculated according to OECD methodology, was approximately 30% less numerous in 1989 than GDR statistics indicated. In 1989, even according to calculations that allowed for comparability, the overall level – when related to total staff and population – of R&D personnel was equivalent to the level in the FRG; the proportional share of the sectors, however, was different, because the GDR had a higher proportion of extra-university research (especially in the academies) and a lower proportion of R&D in the higher-education sector and in the productive sector than in the FRG (cp. Meske, 1993, Tab. 1). Nevertheless, what followed was a cutback of R&D personnel in East Germany from 1990-1993 by approximately two thirds, i.e. to 36% of the former level, while personnel levels by 1995 returned to about 40% of the 1989 level and Figure 3: East Germany: Methodological and real changes in R&D personnel (1 000 FTE) have remained there ever since. The curve for East Germany that is displayed in Fig. 1 is based on this data; if the GDR statistics for 1989 were made the basis of computations, the cutback would have even amounted to 75% and the East German curve would nevertheless lie within the aforementioned interval of the CEECs, between 20 and 40% (i.e. would be equal to 25% in 1993, and from 1995 onwards around 28% of the 1989 maximum).

Analysis of the changes in East Germany focused attention at an early date on the fact that the changes in science and research were not taking place in a uniform way, but that there were great differences between and within the three major sectors of the S&T system. This was then confirmed in the course of a comparative analysis of the transformations within the S&T systems of other former socialist countries, it being notable that substantially concurrent patterns often emerged despite differences of approach to transformation and the course of events associated with it in the individual countries, in particular conspicuous differences between the three major *sectors* of the science system and the R&D system, i.e. higher education (HE), the governmental sector (which in most CEECs was and is centred around the Academy of Sciences/AoS) and industrial R&D (now the business enterprise sector/BES).

2.2 *Comparative Analysis of R&D Personnel Changes in the CEECs in the 1990s*

An analysis of the changes in R&D personnel in the CEECs reveals the basic trends that characterized the 1990s:

(1) In virtually all the countries, the first half of the 1990s saw a considerable reduction in the number of R&D personnel, in most cases to between 20 and 50 of the peak level in the 1980s (cf. Fig. 1). Some successor states to the former SFR Yugoslavia are an exception in this respect, since they recorded only slight declines of between 10 and 20%, or even increases.

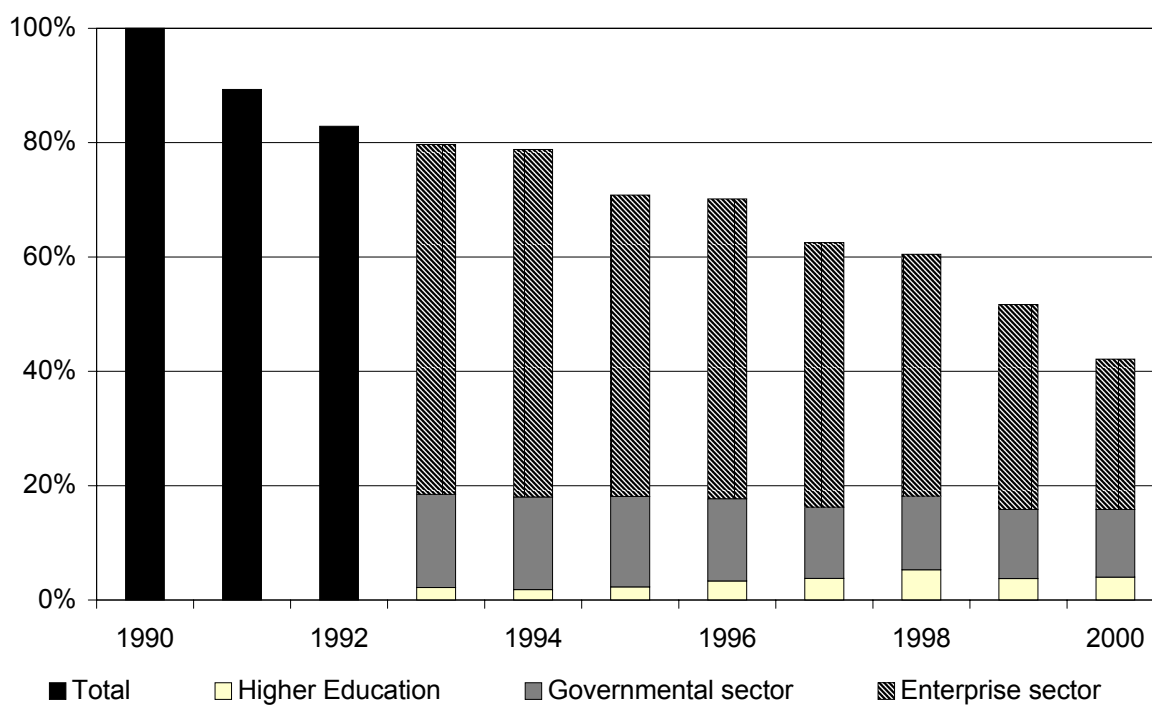
Further differences emerged in the second half of the 1990s. At first, the speed of reduction slowed down considerably in all the countries. In some countries, the reductions then continued, albeit at a slower pace (Romania, Bulgaria); in most countries, however, figures stabilized, while in some countries (Hungary, Russia, and Latvia, for example) they began to rise again slightly towards the end of the decade.

(2) Developments in the three major R&D sectors were even more differentiated.

a) In one group of countries, the reductions were spread out relatively evenly across all three sectors; in other words, there were no major structural shifts. This was the basic trend in European CIS countries (Russia, Ukraine, Belarus) in particular, as well as in Romania (cf. Fig. 4), that is, in countries in which the personnel reductions carried on until the end of the 1990s. Thus, in these countries – and only in these countries – industrial R&D maintained its dominant share of between 50% and 70% of total R&D personnel, which is still largely concentrated in the former branch institutes. To the extent that there were any in-house R&D capacities here at all, their share is below 10%. At the same time, the AoS have been able to maintain and even increase their significant 20% share of total R&D personnel. Although the HE sector has increased its (previously very low) share of total R&D personnel in all the countries, it still amounted at most to only 10% in the year 2000.

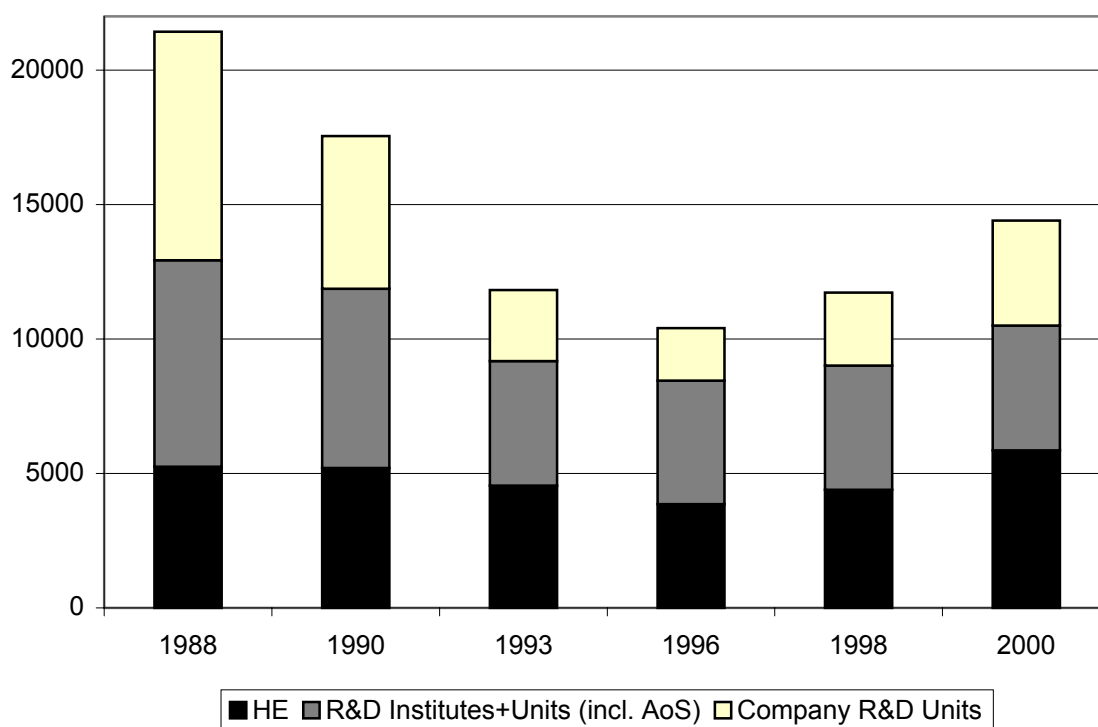
b) In another, relatively large group of countries, the largest losses of R&D personnel were in industry. This group includes, in particular, East Germany (cf. Fig. 3), the Baltic states, Poland, the Czech Republic, Slovakia, Hungary (cf. Fig. 5) and Bulgaria. These losses in industrial R&D particularly affected the former branch institutes, and contrary to all expectations also had a very serious impact on the relatively highly developed in-house R&D capacities in East Germany, Poland, the Czech Republic and Hungary. In this group of countries, as a result, public-sector R&D (HE and government) increased its share of total R&D personnel, in some cases substantially, despite a reduction in absolute numbers in most countries. In some countries (Bulgaria and the Czech Republic, for example), R&D in the HE sector remained relatively weak, while in East Germany, Estonia, Lithuania and Poland it was considerably strengthened. In East Germany, Estonia and Lithuania the governmental, in particular the former AoS sector, was considerably curtailed in favour of the HE sector, while in Bulgaria and Slovakia it maintained or even increased its share.

Figure 4: Romania: R&D personnel by sectors (%)



Source: Own compilation based on Sandu, 2001;

Figure 5: Hungary: Scientists and engineers (calculated FTE) in R&D institutions

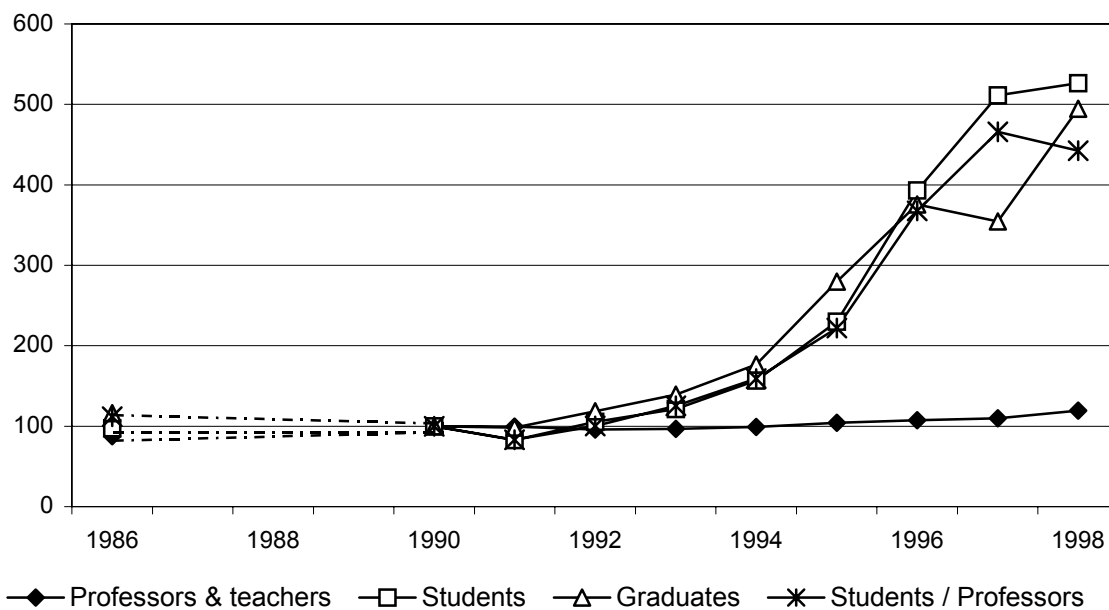


Source: Own compilation based on Mosoni-Fried, 2001.

c) In Slovenia and the FR of Yugoslavia (FRY) there were, at the beginning of the 1990s, only relatively small changes in total R&D personnel and its sectoral structure. In the second half of the 1990s, in Slovenia, the number and share of industrial R&D personnel increased (to 40%) whereas, in the FRY, HE increased its share to 56% and industrial R&D remained at a low level of 8%.

These analyses of R&D personnel changes show that it is usually the *HE sector* that has experienced the lowest cutbacks, and which in some countries has even grown in absolute terms. This statement concerning the development of the HE sector is based on R&D data and is further substantiated when not only this sector's R&D, but also the number of universities and other HE institutions and their total personnel are taken into account. In practically all of these countries a growing diversity of such institutions, including private ones, is apparent and is accompanied by an increase in the number of students and often faculty too. This tendency is also noted in Vietnam (cf. Fig. 6).

Figure 6: Development of Universities in Vietnam (%)



Source: Own compilation based on data from the Statistical Yearbooks of the Socialist Republic of Vietnam, Hanoi (cf. Meske, 2000a, Fig. 4.4).

In all countries this growth of HE is attributable especially to an increase in teaching activity, while research has tended either to be reduced or to be fortified at the expense of the former Academy sector, from which institutes are transferred to the universities. In the *governmental sector* there are widely varying tendencies. In some countries the former Academy institutes

or the public research institutes, as the case may be, have been maintained and strengthened, while in other countries they have faced sizeable reductions or have in some cases been made subordinate to the universities, in particular in Estonia. On the whole, it is *industrial R&D* that has consistently suffered the greatest absolute and relative losses in most countries. That is the case in countries, in which such capacities were concentrated primarily in the independent branch R&D institutes. But it is surprising that the in-house capacities, which some countries did indeed have, have also undergone considerable reduction, because most of the major enterprises in the modern branches of the economy, in which such capacities were concentrated, have by now been privatised, eliminated or heavily downsized.

(3) These sectoral and functional shifts toward teaching and away from research activity were accompanied by changes that varied from one scientific field to another. In this area there is a clearly evident trend toward strengthening the humanities and social sciences, in particular such disciplines as economics, managerial science and jurisprudence, which gain more importance under conditions of market economy and party democracy, as opposed to the fields of natural science and especially engineering, which once predominated in the socialist countries and are now in the doldrums or in some countries even falling in absolute terms. But because of their former pre-eminence their position among R&D activities is still often proportionately fairly strong in comparison to Western countries. One example is the development of figures for post-graduate students in Belarus (cf. Tab. 2).

Table 2: Number of post-graduate students by scientific fields in Belarus

Scientific Field	1990		1995		1997		2000		
	persons	%	persons	%	persons	%	persons	%	% to 1990
Natural	579	19.4	526	17.0	628	15.4	724	13.9	125
Medical	113	3.8	121	3.9	182	4.5	254	4.9	225
Agricultural	147	4.9	144	4.7	181	4.4	248	4.8	169
Engineering	1 097	36.8	842	27.3	1 060	26.0	1 126	21.6	103
Humanities	558	18.7	825	26.8	481	24.1	1 287	24.7	231
Social	434	14.5	403	13.1	738	18.1	1 225	23.6	282
Others	56	1.9	221	7.2	305	7.5	339	6.5	605
Total	2 984	100	3 082	100	4 075	100	5 203	100	174

Source: Nesvetailov and Slonimski, 2001, Tab. 6.4.

These macrostructural and mesostructural changes in matters of organization and activity of scientific facilities have had great influence on the remaining staff and especially on its structures of qualification, function and age.

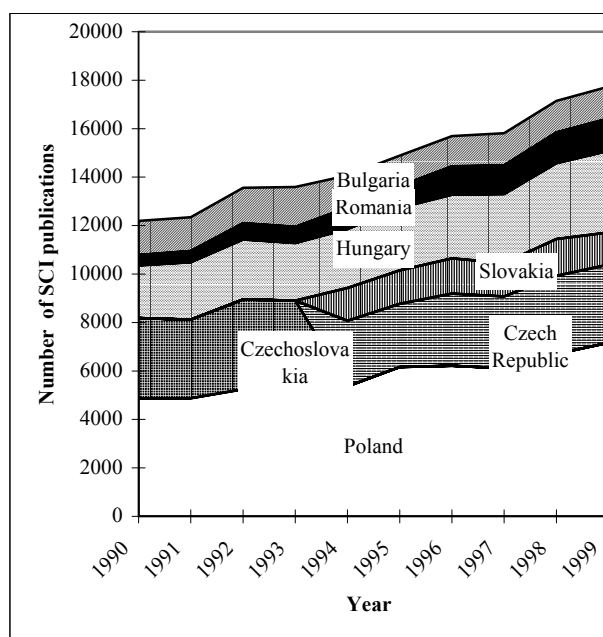
(4) In virtually all countries, the reduction of the number of researchers and/or scientists and engineers was smaller than that of total R&D personnel. This was the case in East Germany, where R&D personnel declined from 1989-93 to 36%, while the number of scientists 'only' went down to 43%; through the transfer of West German scientists into top positions (professors, directors of institutes) the number of scientists rose once again, starting in 1995, to almost 60% of the 1989 level, while total R&D personnel rose only to approximately 40% (cf. Meske, 2001)⁵. An increase in the proportion of researchers and/or scientists and engineers in the total R&D workforce is a phenomenon that is typical of the other CEECs too. In Hungary, for example, the share of scientists and engineers in total R&D personnel rose from 47.5% in 1988 to 52% in 1993 and 59% in 1999. Between 1991 and 1997, the number of scientists with PhD's working in R&D units increased to 124% and of those with Doctor of Sciences (DoS) to 117% of the initial level, reaching a share of 26% of total R&D personnel by 1997 (cf. IRO-AoS, 1999). The latter tendencies are also typical of the other CEECs. In particular, the number of the most highly qualified personnel (with PhD; the degrees of Candidate of Science/CoS and DoS) fell only slightly and in some cases not at all. As a result, the share of these most highly qualified categories within total R&D personnel increased, and in some countries their number even increased in absolute terms. Based on this fact and supported by the elimination of political or other formal barriers to international relations publication activity and also co-authorships with Western scientists have increased considerably (cf. Fig. 7). This confirmed the assessments that scientific standards were mostly adhered in these countries⁶. - but it is still not an indication of durably stable development and

⁵ This is also confirmed by the analysis given by Meyer (1990, p. 39), according to which the overcapacities within the GDR's research potential in comparison to the FRG "do not relate so much to the professional category of scientists as to auxiliary research personnel. In the FRG there are 1.3 subordinate staff members per researcher, in the GDR 2.44 such staff members".

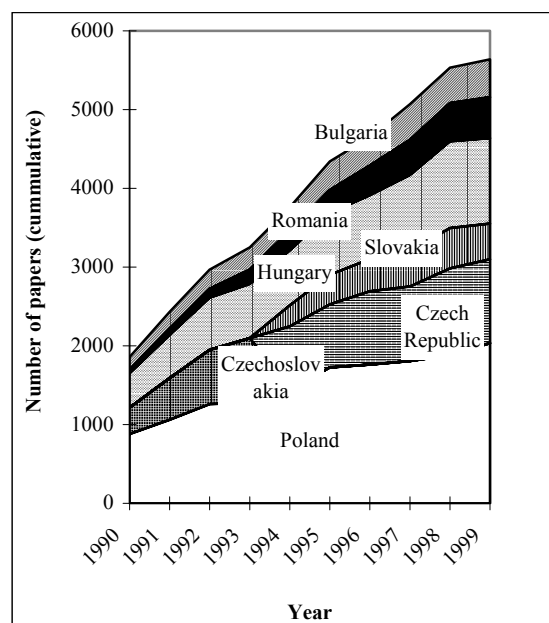
⁶ Assessments (which were indeed critical) made in the course of the evaluation of the GDR science by the (West German) Scientific Council (Wissenschaftsrat) confirmed: GDR science "... was bad in areas in which Western embargo restrictions on the one hand and lack of hard currency on the other hand were effective. In chemistry, for example. But where political circles had certain desires - as in space research - science was very good. It was comparable to ours in the original federal states in the areas in which it was dependent neither upon extrinsic conditions nor special political interests." (Simon 1991: 5). Later, more thorough investigations of selected areas of research in the former GDR with respect to the cognitive and methodological capacities they reflect, also show that scientific standards were adhered to not only in natural sciences and

Figure 7: Publication activity (SCI) of selected CEECs

a) Publications (SCI)



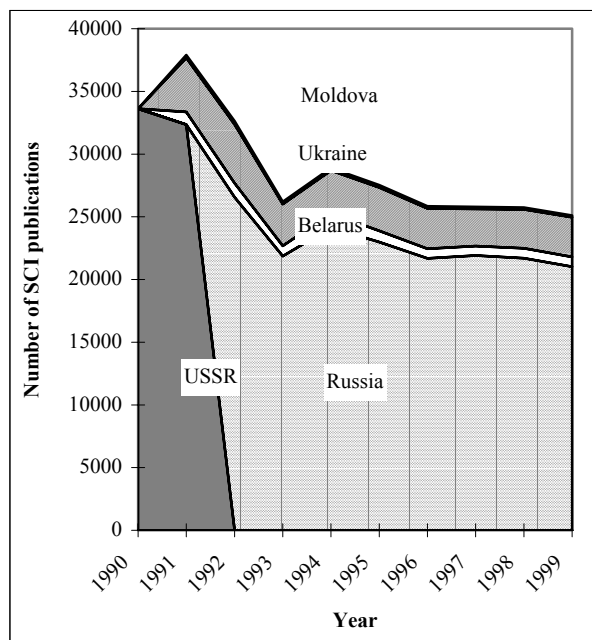
b) Co-authored papers with EU 15 countries



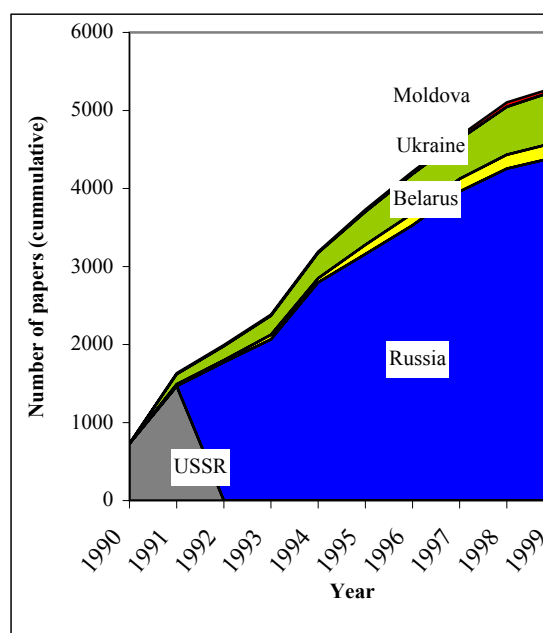
Source: Own compilation based on Czerwon,2000

Figure 8: Publication activity (SCI) of CIS countries (based on Czerwon,2000)

a) Publications (SCI)



b) Co-authored papers with EU 15 countries

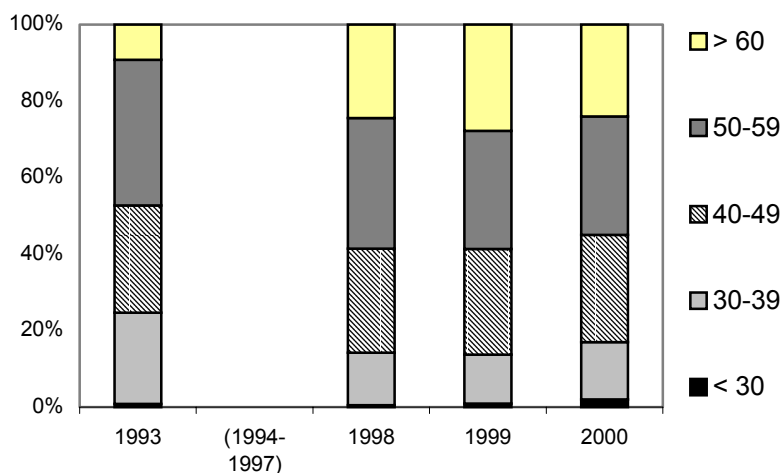


technology, but even in the social sciences of the GDR, despite their orientation to the prevailing system (cp. Kocka and Mayntz, 1998; Mayntz, 1998). Evaluations of science in the Baltic states that were carried out by Danish and Swedish experts in 1992 arrived at similar results (cp. Kristapsons, 2001; Martinson, 2001).

equal collaboration since many of the currently published results are based on research work carried out in the socialist era, which have frequently had to be interrupted in the meantime. Since 1994 the number of publications has dropped again in the four European CIS countries (cf. Fig. 8) and in Bulgaria - while at the same time the number of publications co-authored together with scientists from EU countries has continued to rise: This can be considered an indication of the fact that the lack of resources for R&D in these countries has already begun to have an impact on their output. Not surprisingly, by the end of the 1990s, the dimensions of the most highly qualified personnel categories varied from country to country, with the share of industrial R&D obviously having a very strong effect. Thus the share of researchers with PhD/CoS/DoS within total R&D personnel climbed to as high as 45-50% in countries such as Estonia and Slovakia, where industrial R&D now had a share of less than 10%. Even in countries such as Hungary and Poland, where industrial R&D had a share of up to 40%, the most highly qualified personnel categories made up more than 20% of the total, while in the CIS countries, where industrial R&D still had a 50-60% share, they amounted to only 12-14%.

(5) However, the retention of an above-average number of the most highly qualified scientists and engineers in R&D was associated with major changes in the age structure. Against the background of considerable reductions in the overall number of R&D personnel, it was primarily the young and middle-aged scientists who left the scientific establishments, whether voluntarily or because they were forced to do so; at the same time, very few young people were prepared to embark upon a relatively poorly paid and above all extremely uncertain scientific career. As a result, by the end of the 1990s, there were virtually no scientists under the age of 30, and even the share of those under 40 had declined dramatically (in Lithuania from almost 24% to under 13% from 1993 to 1999; it only began to increase again in 2000; cf. Fig. 9)

Figure 9: Age structure of scientists in Lithuania (%)



Source: Own compilation based on Dągys, 2001, Tab. 9.6.

On the other hand, the share of the over-50s and over-60s rose significantly (in Estonia, the share of researchers aged over 50 rose from 34% to 44% between 1991 and 1999; in Romania, the over-40s had risen to 62% by 1999). Only in successor states to the SFR Yugoslavia were measures taken to counter this trend, a particularly problematic one for the future development of science and technology, by instituting a number of special support programmes for young people. As a result, the average age of researchers in Slovenia fell from 44-46 years in the 1980s to 38-40 at the end of the 1990s (Stanovnik, 2001). In the other countries, there have only in recent years been signs that interest in studies leading to a PhD and careers in science is beginning to grow once again (cf. Tab. 2).

The picture that emerges from this comparative analysis of the basic changes in the number and structure of R&D personnel should be regarded only as a broad outline. It provides some initial insights into the very significant changes that took place in both the position of R&D in the transitional societies of the CEECs and the organizational and personnel structures within their S&T systems. However, quantitative analysis alone is more likely to raise questions about the causes and consequences of these changes than to provide satisfactory answers. Such answers are more likely to be gained when we supplement the quantitative analysis with qualitative studies of the institutional transformation of S&T, that is of the changes relating to the most important actors, their behaviour and the rules determining or influencing that behaviour.

3. Institutional Transformation of National S&T Systems

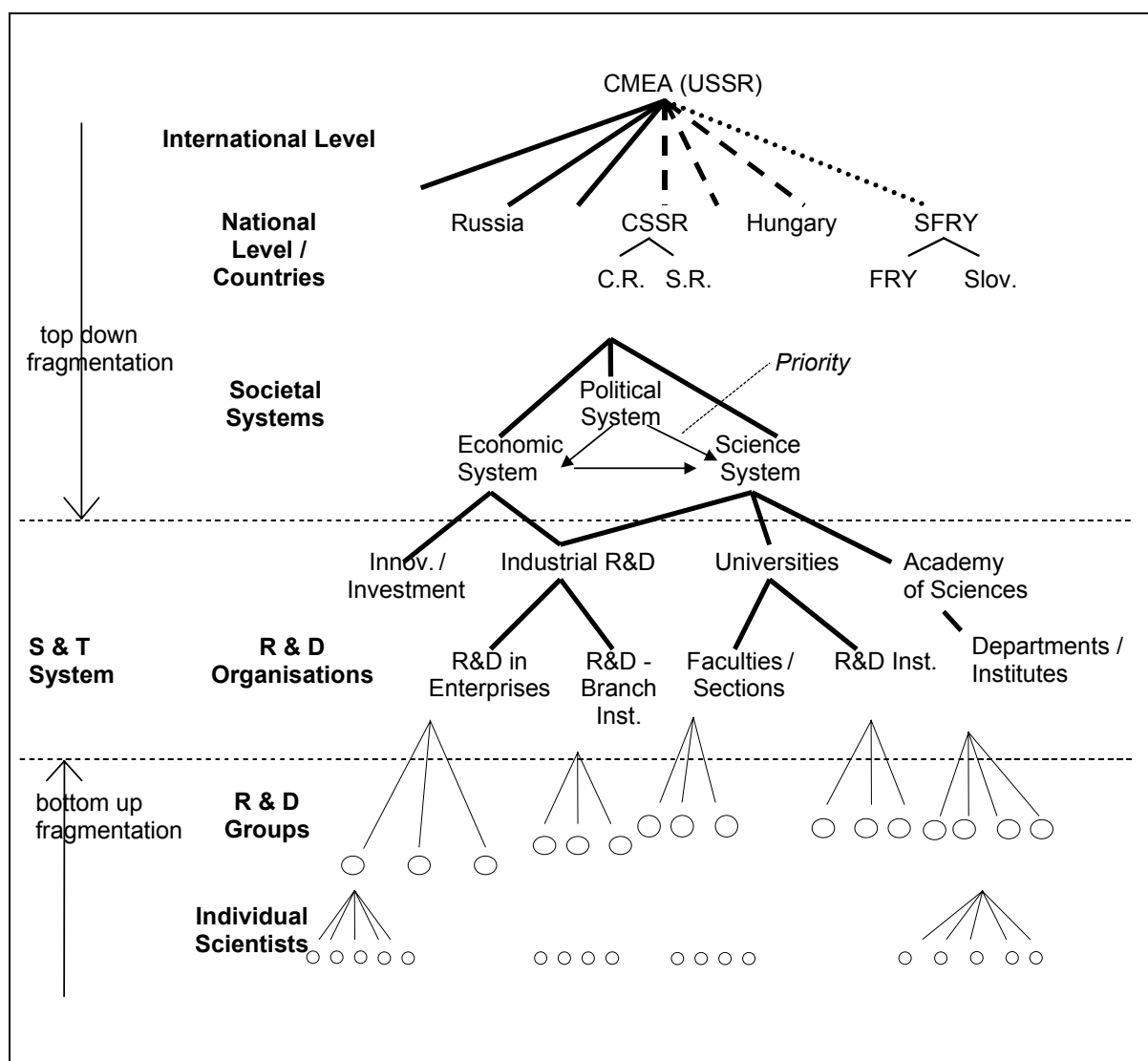
Fig. 1 depicts not only the basic trend of personnel reduction in R&D, but also certain differences in the trajectory of the curves over time, along with the outcome of the trend in quantitative terms at the end of the 90s. As our comparative analysis of the institutional changes in the S&T systems of the CEECs has demonstrated, these differences have been heavily influenced by the concrete internal and external circumstances of the individual countries both before and during transformation, as well as by the particular way they are coped with (cf. Meske, 1998 and 2000).

3.1 Three Phases in the Institutional Transformation

Whereas the structural changes in science and research have hitherto been described primarily on the basis of resource allocation, changes to the institutional and functional spectrum of science and research represent another large complex. Changes within former socialist countries are symptomatic of a fundamental changeover to another social system, which under the conditions specific to each country have led in science and technology, as in other fields, to a greater or lesser degree of diffusion and fragmentation at various levels of the former S&T system (cp. Fig. 10). The complexity of these top-down and bottom-up changes is revealed by circumstances ranging from the interruption of international contracts to the dissolution of hitherto existing unitary states (USSR, CSSR, SFRY) all the way to the changed affiliation and activity patterns of individual scientists, whether imposed or voluntarily undertaken.

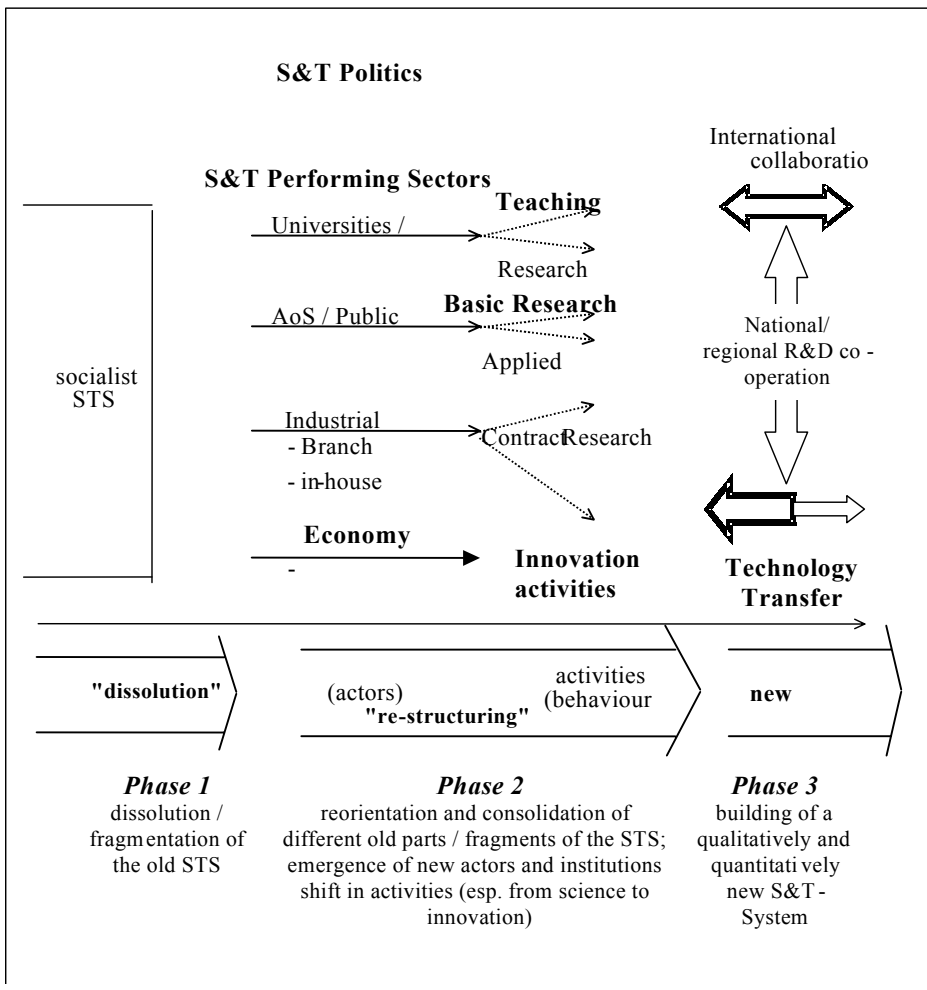
As our comparative research in East Germany and other CEECs has shown, three fundamental phases may be distinguished, which almost all countries have passed or are passing through (cp. Fig. 11). Fluctuations with respect to time result from different starting points, the varying duration of individual stages and also the amount of overlapping between them. Today we can safely say that the first phase of dissolution and fragmentation of the former STS had come to an end in most countries by the middle of the 90s; and that the second half of the 90s was characterized chiefly by the second phase, that in which the remaining and/or newly established organizations and their activities were restructured and consolidated. In East Germany these first two phases ran their course with extraordinary speed. By 1990/91 the GDR's centralistically organized S&T system had for the most part been done away with – through the dissolution of the AoS of the GDR, the transfer of responsibility for HE to the

Figure 10: Levels of dissolution and fragmentation of the former socialist S&T system



new 'federal länder' and the privatisation of the former 'Volkseigene Betriebe' (VEB) [the state-owned 'People's Enterprises'] by the 'Treuhandanstalt' [the curatorial body that supervised privatisation]. In the course of the GDR's accession to the FRG, the formal establishment of new institutions in East Germany was relatively sweeping and quick in the area of S&T too, due to the 'transfer of institutions' from West to East Germany (cf. Lehmbuch, 1992; as to the approaches undertaken in different S&T sectors cf. Hilbert, 1994; Mayntz, 1994a and 1994b; Labrousse, 1999). Here, therefore, the second phase was by and large finished in the middle of the 1990s (cf. the quantitative results demonstrated in Fig. 3). In other countries undergoing transformation, the search for institutional solutions of their own (with regard to actors and rules, cf. Mayntz and Scharpf, 1995) and their implementation were required, and accordingly, more time was needed.

Figure 11: Three-phase model of institutional transformation of STS



In some CEECs, this second phase therefore lasted until the end of the 90s and is to some extent not yet finished.

As Figure 11 illustrates, clear changes to the role and the activity spectrum of the main actors of the science and technology system are discernible as the former science system restructures. Government *science policy* has lost the clearly dominating role it once held in all sectors, including that of the business enterprise sector, a role that had been especially one of macrostructural co-ordination in science and research. In a number of countries it had even withdrawn completely from R&D in the industrial sector for a certain period, e.g. in the Czech Republic (cf. Müller, 2001). The most substantial advances were the granting of autonomy to HE institutions and non-university research facilities and their re-organization, which was based largely on the evaluation of units and individuals. While advances in institutional restructuring dominate in the higher education sector and have been making good progress in the Academies of Sciences and other public R&D institutes, the situation in

industrial R&D must, in contrast, be assessed as difficult. In most countries the reorganization of the former branch R&D institutes was far from reaching completion in the mid-1990s, and the aim of strengthening in-house R&D (personnel, funding) and building it up as a core area of the new R&D and innovation system remained largely unfulfilled (cp. Meske et al. 1998; Meske, 2000, Tab. 1; EC, 1999). Quite a number of these former institutes, or what remains of them, are therefore now almost non-existent as 'research institutes', and have instead in most cases poised themselves as purveyors of scientific and technical services and as innovative small enterprises. It is here, in the area of applied or industrial research and experimental development, that the greatest changes in the functional profile of the formerly utilized capacities is to be noted. They express themselves in immediate terms as high losses of R&D capacities. Some of these capacities, however, have shifted to another function and have helped to fill a gap in the spectrum of necessary activities between research and innovative production (cf. Webster, 1996), so that this 'displacement' is often a positive structural change within the S&T and innovation system. In the enterprises themselves, there has often been a noticeable increase in innovative activities and major technological change; the special quality of the process being, however, that these activities are usually no longer based on research, let alone on indigenous research. They are instead realized primarily through technology transfer from foreign countries, usually in connection with the import of goods and foreign direct investment. Pertinent analyses do indeed point to a positive influence, but also to the selectivity and limitations that this technology transfer has in its effects upon sustainable and comprehensive technological change (cf. Dyker, 1997; Hunya, 2000).

In contrast to the first half of the 1990s, the second half of the decade, and particularly the situation in the years 2000 and 2001, was characterized in virtually all the CEECs by stabilization in both the political and economic spheres (cf. EBRD, 2001). This indicates to us that the radical changes on the macro level are nearly complete and that the transition to a 'normal' pattern of development in a new social environment that functions in accordance with the principles of democracy and market economics is now underway or already complete in most of the CEECs. The main reason for these generally positive developments is the institutional changes that have taken place in the economic sphere, which have involved extensive, though in some cases incomplete, liberalization, privatisation and enterprise restructuring. The process of change has been subject to delays and setbacks, particularly in the European CIS countries and the FR Yugoslavia, while in Romania, following the elections

of the year 2001, fresh attempts are being made to rapidly privatise and restructure the economy (cf. EBRD, 2001: Country Assessments).

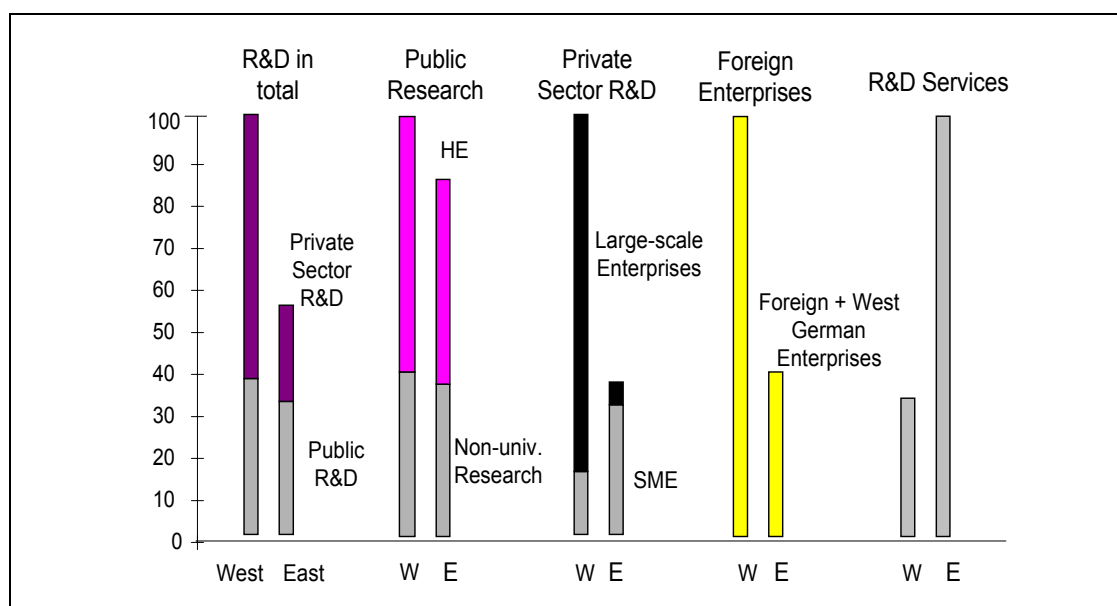
Consequently, the process of institutional adaptation to OECD norms is far advanced in the area of S&T. The European Commission, in Chapter 17 of its 'Regular Report 2001' (EC, 2001b) published in November 2001, also confirms further progress and/or a relatively high level of alignment with its 'acquis communautaire' in the area of science and technology in virtually all the ten candidate countries studied here; the only reservations expressed concern Bulgaria, Romania and Latvia. In my view, such reservations regarding the completion of the process of institutional restructuring in this area must be extended to the CIS countries and, as a result of the recent political changes, to the FR Yugoslavia as well, and in particular to the Republic of Serbia (cf. Kutlaca, 2001).

On the other hand, in a number of countries, especially those that are candidates for EU membership, there are already indications that a new, nationally and internationally integrated S&T system is under construction. This third phase of institutional transformation, however, has not yet run its course in all countries. Generally, even such countries as Hungary and Poland, advanced in the process of transformation, still stand at the beginning of this phase. It is especially at this point in time, now that the consolidation of individual actors has been completed, that the problems and difficulties associated with the establishment of new and effectively functioning S&T *systems* under conditions of international opening and globalisation become evident and lead, among other things, to slow and sometimes unstable development of S&T, as is the case in East Germany since the middle of the 1990s (cf. Fig. 3).

In East Germany there has been since the mid-90s a landscape of science and R&D that not only differs fundamentally from the previous GDR system, but also in essential aspects from the R&D system in the old (western) federal states (cp. Fig. 12). The virtual absence of innovative large enterprises and the dominant share held by the subsidiaries of West German companies, almost invariably without any major R&D capacities of their own (these subsidiaries having a share of at least 50% of the total workforce, but less than 15% of the industrial R&D workforce, which is small anyway, cp. Spielkamp 1998, p. 77; Stifterverband, 1995, p. 5), have led to major disparities between industrial and public R&D and create new developmental problems for the latter, which stem from low opportunities in the region to procure R&D orders, student internships (work experience), employment opportunities for graduates etc. For this reason, in East Germany too the process of setting up a fully functional

Figure 12: Comparison of R&D structures in West and East Germany

(Comparable relations in staff levels)



Note: R&D services are enterprises that fulfil R&D tasks for private and public contractors: In East Germany they were principally created from the former GDR branch R&D institutes

Source: The data for East Germany were multiplied by 4.6 for this comparison, in accordance with the employee ratio of 1:4.6 between East and West Germany. As the population ratio lies at only 1:4.1, the East German data are somewhat too high. All data for the year 1996.

regional science and research *system*, i.e. the third phase of institutional transformation, is not yet complete. Since 1996 there has been a proliferation of views that hold the original concept of rapid economic catching-up to be unsuccessful in East Germany, meaning that for this part of Germany new and independent solutions and development opportunities must be sought out and found.⁷ As an expert opinion provided by the leading economic research institutes states, the prospects of the East German economy can at best be „assessed with guarded optimism. In the medium term the recovery process will get back into gear... One must nevertheless avoid succumbing to illusions: the road that the East German economy has yet to

⁷ Under-secretary Ludewig (Chancellor Kohl's spokesman on East German economic affairs) warned as early as 1996 against reducing the economic development of East Germany to a 'mere race to catch up with the West': 'We need an independent, self-sufficient economic structure in East Germany' (quoted in the *Berliner Zeitung*, Nov. 25, 1996, p. 16). In 2000 President of the Bundestag Thierse of the SPD advanced his thesis that East Germany is 'tottering on the brink', provoking a new discussion, which still continues (cp. AG Perspektiven für Deutschland, 2001).

travel is still long“ (Kurzexpertise, 2001, p. 34). This conclusion must necessarily be considered just as valid for science.

3.2 *The Decisive Influence of Political and Economic Factors on Changes within S&T*

The particular feature of transformation in former socialist countries, as opposed to other examples of social transformation such as Spain (cp. Bernecker, 1997), is precisely the fact that here all areas of society were undergoing fundamental change simultaneously, and to an extent still are. All changes in science and research must therefore be localised in these contexts, which were and still are chiefly ones of dependency of science on its ‘environments’ (Krohn and Küppers, 1989) in the political and the economic fields. In the GDR this proved to be especially important in 1990, when efforts toward renovation in the field of science itself were rigorously stopped by the last GDR government, the first to have been freely elected, and were then supplanted by processes of institutional transfer from the West to the East, which were controlled for the most part by West German actors (cp. Gläser, 1992; Krull, 1992; Simon, 1992; Stucke, 1992).

On the political plane, the systemic change in all of these countries ushered in a new and usually unstable field of parties, which only gradually enhanced their profile and became established and solidified as political representatives of certain group interests. A characteristic feature of political developments at that time was therefore the relative frequency with which ruling parties or party coalitions changed. One particularly vivid example is Bulgaria, where seven governments and five parliaments between 1990 and 1997 gave rise to discontinuity in economic and legislative measures (Simeonova, 2001). But in all of the other countries too, governments, regardless of the parties involved, faced strong economic pressure because of the drop in GDP and were occupied primarily with economic and social problems. Under these conditions science was always relegated *de facto* to a secondary role. In addition, the new political forces were almost unanimous in criticising and rejecting for ideological reasons the former socialist policy of ‘priority’ development of science. These two factors go a long way toward explaining the attitude that predominated in the political field at the beginning of the 90s, which led to the sharp curtailment of financial resources placed at the disposal of science. The differences that the various governments nevertheless exhibited in their approach to science and which became more pronounced in the second half of the 90s, had various reasons of their own. In Bulgaria and in the Baltic countries there was a widespread view that the system of science set up after 1945 or

remodelled on Soviet lines, was a Communist structure and as such primarily a part of the old system of rule and something that therefore had to be eliminated or at least fundamentally modified⁸. By contrast, in the European CIS states, especially the Ukraine, but also Poland, science was regarded as a part of the national (cultural) heritage that was intended to be revitalised. In these countries it was therefore preserved and promoted to a degree that is rather remarkable, when measured against the restricted economic leeway. Also, in all of these countries a view was aired in connection with democratic movements and the demand for greater individual freedoms, which stated that university enrolment, once heavily regulated, had to become more free. It was for this reason in particular that universities, especially instruction, study, and as a consequence university research too, were at least maintained and indeed in most countries promoted and strengthened. With due consideration being given to the particular constellation of interests and to professional prospects, the previously cited structural changes had an effect that favoured the humanities and social sciences, with support coming from political endeavours to create a new elite that was oriented toward market economics and party democracy. In the HE sector there was to this extent a harmony of interests encompassing politics, science and the productive sector, which was often augmented by persons exercising multiple social functions, such as university scientists, who were especially likely to be members, often in leading positions, of the new political parties (in Hungary and the Czech Republic, for example). All of this explains the relative and often absolute strengthening of the position held by the HE sector in practically all transformation countries.

By contrast, there was a much more variegated range of opinions in the new political (and also entrepreneurial) circles with regard to the necessity or the dimensions of research capacities in general and the Academies of Science and other state research institutions in

⁸ In Bulgaria the 1990 to 1992 period was characterised both by sharp criticism of the scientific field and by several initiatives to restructure its totalitarian institutional framework. In 1992 a special “Law on Decommunisation” was passed, under the terms of which some categories of HE and research staff who had been involved in ideological and political activity in the previous regime are deprived of the right to participate in the leading scientific bodies for five years. This law was repealed in 1995 (Simeonova, 2001). In the Baltic countries the traditional universities were strengthened, while industrial research and the AoS, which were characterised mainly by Russian interests, were radically downsized, and even some of the academic degrees acquired in the Soviet period were regarded with suspicion and made subject to nostrification, i.e. a *post facto* recognition process (Dagyte, 2001).

particular. While there usually was general accord about the responsibility of the state for basic research, opinions differed widely as to the necessity or the possible dimensions of basic research in these mostly rather small countries, and they differed even more when it came to the organisational forms, in which it was to function. This was most expressly the case when the Academies of Science were dealt with. Opinions and proposed measures ranged in this case from their dissolution (as practised in the GDR and in the Baltic countries) and the intended concentration of research at the universities, through the maintenance of the Academies (which were to be oriented to basic research), all the way to the fortification and upgrading of the AoS as national research institutions, e.g. in the Ukraine and in Belarus⁹. This governmental sector has therefore, as governments change and new political constellations appear, often been subject to different kinds of treatment. The conduct of political circles or of governments with respect to research institutes in industry, which were once mostly organised by the state, is characterised by a wide spectrum of differing behaviour. In the Baltic countries the industrial research institutes that had been taken on from the Soviet period were regarded as foreign bodies, while in the Czech Republic the influence of neoliberal views led to industrial research being totally abandoned to the market for a lengthy period. In both cases the result was a rapid decline or the complete disappearance of such institutes. In other countries, however, it was acknowledged that the state had an obligation toward these institutes too, at least for the duration of the transition from planned to market economy, which enabled a gradual and flexible changeover in this sector. In Poland there was an evaluation and ensuing differentiated funding of the former branch institutes; in East Germany many of the former branch institutes of the GDR were reconstituted as external research units that worked according to market principles, and whose core substance was preserved through a series of government aid programmes conducted by the Ministry of Economic Affairs and the Ministry of Research (Meske and Schrauber, 1990; Hilbert, 1994; Kohn, 2001). In Hungary a differentiated approach was practised, one that ranged from closure through privatisation (which was aimed at in the long term) to continuation of a few institutes as state departmental institutes (Bouché, 1998; Mosoni-Fried, 1998). The divergent political attitudes – before the background of the depletion of funds available for distribution – maintained by the various governments during the 90s provide an

⁹ On May 15, 1997, the President of Belarus issued the edict which transformed the Academy of Sciences of Belarus from a self-managed scientific organisation into the National Academy of Sciences (NAS) of Belarus with the status of a higher state needed scientific organisation (Nesvetailov and Slonimski, 2001).

explanation both of the common trend to cut back on R&D, which is the picture that emerges from the analyses, and of the differentiation between countries, over time and by sectors and fields.

Moreover, the direct influence of the *economy* on R&D capacities must be taken into consideration. In all countries the transition to a market economy was followed by the establishment of new independent enterprises as the actors of determining importance. The approach was marked by the ideological views upon which it was based and by the privatisation procedures that had their origins in those views; on top of that there was the interest of foreign enterprises, especially of multinational corporations, in investments and/or the take-over of companies, an interest which differed from one country to another. As a result, the economic transformation and the restructuring of enterprises that are relevant to R&D ran very different courses (Radosevic and Auriol, 1999; Hirschhausen and Bitzer, 2000). An essential component of the newly established spectrum of enterprises is that of the remnants of former major firms, which are still owned by the state; they have been joined by a large number of mostly smaller indigenous private companies, either new establishments or spin-offs of previously existing entities, and a group of enterprises that are foreign-owned or have foreign participation, the size of which varies from country to country. A common trait of the large and small native enterprises is the fact that innovation either fails to materialise (mainly for lack of resources) or that it does so only sluggishly and then chiefly by building on their own former R&D results and/or as technology transfer from abroad. The establishment of the local subsidiaries of Western enterprises entailed mainly the use of foreign know-how. For these reasons almost none of these very different enterprises have to this day a current need for new R&D results. That means that there has been practically no demand for indigenous R&D in the past decade. The R&D facilities that in some cases exist within companies have – with a few exceptions – been made independent or shut down; a few foreign enterprises have, especially in Hungary, taken on parts of the local R&D capacities and fit them into their international network of expertise (Mosoni-Fried, 1998; Günther, 2002). At the same time, lack of demand allowed for only rudimentary implementation of the intended conversion of former branch and Academy institutes into market-oriented R&D suppliers that were financed by outside orders for services. Even in East Germany, analyses carried out in 2000 show that without project funding supported out of various public (regional, national and EU) sources, most of the R&D-based innovative SMEs would not have survived (Kohn, 2001).

The transformation of the industrial R&D facilities has therefore led to a substantial reduction of R&D capacities and to the survival of some of their individual components as service providers and producers of goods. In this respect, the fairly even reduction in all sectors, with relatively more industrial R&D being preserved, a situation observed in the CIS countries and in Romania, is not necessarily to be seen as a positive sign, but more as a consequence of the hitherto unimplemented restructuring of the enterprise sector and of the economy as a whole (cp. Radosevic and Auriol, 1999). The main reason for this is that the transformation of the former national S&T systems from socialist economic planning to capitalist market economy is taking place under conditions of increasing internationalisation and globalisation of the world economy. This changes not only the microeconomic level of the individual companies (as conditions of centralism and economic planning give way to those of a market economy), but above that level has profound effects on the macrostructures in each nation's economy. For example, one effect is a new international distribution of economic activities, as the transformation countries have become newly acquired markets for multinational enterprises. Their company headquarters together with closely associated (science-intensive) functions and the main production sites remain in their traditional locations and from there they supply the newly won markets. In Central and Eastern Europe, at best more or less dependent production sites without substantial scientific and technological functions are set up. This however alters the demand for industrial R&D in the transformation countries in a way that is not just 'transformation-related', i.e. short-term and temporary (a period of 5-10 years having been expected in the beginning in East Germany). Instead, additional permanent structural changes are taking place in this area on an international scale, which for the most part have a detrimental effect on the inherited industrial capacities in the transformation countries. It is not yet possible to assess the extent to which this structural change has lasting negative effects not only on industrial R&D, but on its hinterland in the field of academic instruction and on research in other sectors, e.g. the IT and service sectors, nor is it possible to assess the extent to which the growth of the latter sectors might counterbalance the effects of structural change on industrial R&D (cp. Hirschhausen and Bitzer, 2000).

The changes in S&T in individual countries thus reflect not only the transformation of science, but also the new conditions and constellations of interests within society and the way they are at least in part being dealt with by introducing and imposing new institutions in science and technology. Whereas the first two phases of the dissolution and fragmentation of the former socialist S&T system and the consolidation of remaining actors etc. (cp. Fig. 11)

were traversed more or less quickly in all countries, all former socialist countries still face the task of getting through the third phase, that of building a new and more effective S&T system, which will be fully integrated both nationally and internationally, able to perform at a high level and stable in the long term. What such a system should look like and how it should be shaped under conditions of increasing European integration and economic globalisation, is presently quite an open question (even in East Germany; cp. AG Perspektiven für Ostdeutschland, 2001; IWH, 2001; Thierse, 2001).

But experience in Western countries shows that there are in any case major differences in this area between individual countries and within them between individual regions. This is corroborated by, among others, the most recent EC studies on regional differentiation of innovation and R&D activities on the territory of the EU (Laafia, 2002). We assume that this regionalisation will also affect the countries of Central and Eastern Europe, as shown by the differences in development that are already in evidence, for example in Hungary, Slovenia and the Czech Republic on the one hand and in Bulgaria, Romania and the FR of Yugoslavia on the other. However, it also has an effect within these countries, causing certain urban agglomerations to become centres of growth (usually such capital cities as Budapest or Warsaw; in Poland a number of regional centres too, cp. Kuklinski et al., 1997), while other regions with obsolete industries fall further behind. Experience has been similar in East Germany too, and as a consequence, the previous strategy of achieving the most balanced development possible in all of the new federal states has been given up; state support is to be concentrated more on specific growth core areas in the future (cp. IWH, 2001). It has become evident in this case that while scientific institutions are a big factor in favour of a particular locality and provide good preconditions for regional development, this 'asset' is only effective if it is not only supported by political forces but also has strong partners in local enterprises that have a capacity for high performance and innovation.

4. Résumé and Conclusions

A wide variety of effects, some of them mutually contradictory, derive from the changes in science and technology that have been elucidated above. This variety is what makes matters appear very murky when it is asked whether science in the former socialist countries is to be judged an asset or a liability for the transformation and for future development, and when the question of the causes and effects of the changes arises. Using the findings contained in Sections 2 and 3 as a starting point, and after more than ten years of social transformation, the soundness of the arguments set forth in Section 1 concerning the future of S&T in former socialist countries will be put to the test in the following discussion.

4.1 Substantial preservation of R&D capacities or dismantlement as a consequence of 'insufficient quality'?

a) The substantial dismantlement of R&D resources, including R&D personnel, to less than half of their former dimensions in almost all transformation countries is a sign that efforts to preserve R&D capacities have largely failed. Indeed, real losses have been incurred as some personnel has drifted away, including top-notch scientists. The remaining personnel has been lagging more and more behind, as a multitude of structural and institutional changes, shortage of funds etc. have clearly degraded working conditions and in this way put limitations on the real ability of science to perform. An increase in the percentage of older employees in the current workforce is a general feature and gives rise to the new danger that in approximately ten years the STS, just restructured, will suffer a further setback due to personnel gaps that could once again weaken it (cf. Nesvetailov, 1998).

b) But much of the quantitative drop in R&D personnel is due to a certain degree either to changes in the methodology of data collection or to organisational changes. The institutional and structural changes in the STS point to the fact that despite considerable losses, the qualitative core areas of science, i.e. the most qualified research and teaching personnel as well as the embodied resources of knowledge, experience and methodological ability, have been essentially maintained. The considerable quantitative changes to R&D, which can be demonstrated statistically, should not be overestimated in the effects they have on actual scientific and technological capacity, at least in a few of the former socialist countries. The increased activity in internationally noticed and co-authored publication is one feature of the surviving scientific potential, and the emergence of spin-offs and other innovative enterprises

is another one that helps to build new domestic bases for innovation, supplemented by FDI. The nonuniformity of development in the transformation countries, along with the once again observable decline in such activities in some of them, points to the fact that the changes have not yet (everywhere) come to their conclusion.

c) It is precisely the retention of the most qualified scientists and their increased international publication and co-operation activities, together with the acceptance of a considerable number of émigré scientists even in leading OECD countries, that clearly speak against the argument that science in the countries of the 'Eastern block' was of „insufficient quality“. That this could have been the reason for the cutbacks that did take place is also refuted by the various evaluations of scientists, which tended on the whole to be positive. This in no way excludes the existence of a few cases, in which the reverse applies (cases which certainly exist in any country!), but may in no event be viewed as the reason for the personnel cutbacks in their totality¹⁰.

It must therefore be noted that a major dismantlement of R&D capacities has indeed taken place, but not one that might in any way be attributable to deficient quality of science and scientists in the socialist countries. That does not, however, answer the question as to the real cause of the dismantlement of R&D and the role science actually played in the systemic transformation.

4.2 Is science a necessary prerequisite for the transformation of society and a new economic upturn?

a) In most CEECs the *political changes* ran their course almost unimpeded, i.e. they developed their own dynamics and involved decision-makers who had little regard for scientific counselling or even acted in contravention of its advice (as in Germany, where the Kohl government had been warned against the variant of monetary union that was later put into effect; cp. ...); in other countries too, such concepts that stem from scientific counselling have only at times won out against others (e.g. the Balcerowicz plan in Poland, the Klaus reforms in the Czech Republic, cp Müller, 2001) and in retrospect they have been criticised as off-target because of their negative effects (e.g. ... IMF and World Bank...). Aside from the

¹⁰ This argument was therefore more than anything else an expression of ignorance with respect to a science that was little known in the West, an ignorance that is still having its after-effects and which is as the „proverbial arrogance of the West toward the East one of the most embarrassing residues of the cold war“ (Wagnerova, 2002, p. 534).

(relatively frequent) cases of scientists switching into political activities and careers, science itself has exercised little influence on the political changes. That means at the same time that the argument which declares research potential to be a necessary prerequisite for the active preparation of transformation processes and carrying through with them, hardly squares with reality. This was at least partly due to the fact that social sciences in the East (and in the West) were surprised and caught unprepared by the changes as they occurred, and only in a process of descriptive accompanying research did they arrive at analyses and preliminary interpretations, and even then hardly to theories or conclusions of practical utility (cp. Mayntz, 1994).

The situation in the still socialist countries of Vietnam and China is different to the extent that in their case a slower, centrally controlled version of transformation has been realised that clearly differs from the one observed in Eastern Europe. These two countries have therefore also been able to utilise their scientific potential in order to learn from the experiences of transformation in the CEECs and to find better-suited approaches for the transition to market economics, something that the hitherto quite successful economic development of both countries proves.

b) In the *economy* the transformation took place under the influence of the new political actors and their (mostly Western and Western-oriented) advisers. Here, however, the changes usually proceeded more slowly than in politics, and if only for that reason they were often more duly considered. In the privatisation and restructuring of enterprises, whatever R&D capacities that might have been present were hardly taken into consideration, to say nothing of using them as the starting point for remodelling and modernisation – to the contrary, the privatisation often brought about their dismantlement. Only in exceptional cases did foreign corporations take on not only production sites, but also relevant R&D units that had an acceptable level of performance (partly, especially in Hungary). In the fewest of these cases were the R&D capacities actually the deciding factor, and their maintenance tended more often to be a mandatory stipulation (in other words, here too they were more of a liability than an asset!). The dismantlement of industrial R&D took place all the more quickly, the sooner ‘large-scale privatisation’ took place and the more it was left up to the market (as in the Czech Republic), and it took place more slowly, the more protracted the transition and the process of international opening were (as in the CIS countries), or the more there were and are political forces interested in the preservation of the R&D capacities (in hope of achieving rapid economic revitalisation, as in East Germany and Poland, or in the interest of rapid

industrialisation and modernisation, as in Vietnam and China). Accordingly, in the sector of traditional industrial enterprises, the existing R&D potential has in the past ten years played a very minimal role in the renovation of products and enterprises.

Yet the economic transformation was also characterised by the establishment or expansion of an indigenous sector of SMEs, with innovative companies being founded as spin-offs or by the personnel in R&D units as start-ups. Many scientists and technicians have migrated from the once highly developed R&D sector into the enterprise sector. There they have helped with their scientific and technical expertise and experience to fill a gap in the former socialist innovation system by contributing to the rapid adoption and adaptation of modern organisation, technologies, equipment and services and to meet international standards in the business enterprise sector. Especially the candidates to EU membership have in recent years adapted to most of the scientific and technological standards, regulations, requirements etc. that are valid in the EU as ‘*acquis communautaire*’ (cp. EC, 2001b). These matters could never have been coped with in such a short time, had it not been for previously accumulated educational and research experience.

Also with respect to the transformation of the political and the economic system in the CEECs, as well as Vietnam and China, divergent results and tendencies concerning the role of science and research are evident. They point in particular to the different levels of need for science and research, or, as the case may be, the varying perception and attention accorded it by the political sphere – aspects that were declared essential for the fate of S&T in discussions as early as the beginning of the 90s.

4.3 Are needs for science and research changing and leading to devaluation of the skills and experience of scientists?

a) The *sectoral changes* within the S&T system of the transformation countries are evidence that in the past decade the demand for higher education has generally increased, while the demand for research, especially for industrial R&D, has clearly declined. The growing demand for HE, evidenced by the increased number of students, was the deciding factor for the strengthening of the role of the HE sector in the S&T system of all countries. It is obvious that the population of these countries (through its demand for education and partly through its private investments in it) together with the political sphere (through the opening and diversification of the universities and other HE institutions) under the new social conditions

more than ever see education and qualification as chances for the future; in doing so, they are following the trend of the leading OECD countries.

That this growth of HE has been realised, despite economic and other problems, is itself an indication both of the fundamentally intact ability and willingness to achieve, and also of the ability to learn and the flexibility that characterise the HE institutions that were taken on from the socialist era or that have now – often with Western help – been newly founded, and that of their scientific personnel. In this sector the S&T potential has thereby proved to be an essential resource for the maintenance and development of knowledge and learning, in other words, an asset. This is especially true of China and Vietnam, which, as developing countries or as a former colony, only in the socialist era became able to educate highly qualified scientific personnel of their own. For Vietnam in particular, the support of the other socialist countries was indispensable as a well-developed education system (Jordan, 1992) with some top-notch experts in R&D (Annerstedt and Sturgeon, 1993, p. 67) was built up (cp. Pham Huyen and Dang Duy Think, 1990).

b) The decline in *R&D capacities*, on the other hand, bears witness to several facts, among them, that

- in most socialist countries R&D capacities even under the prevailing conditions of the time were (at least partially, especially in the arms sector) oversized and organisationally bloated, and in the course of transformation they were therefore pared down to the internationally customary dimensions or relative size;
- the economy took a nose-dive with the collapse of the CMEA, which led to a decline both in funding for R&D and in the real need of the economy for R&D results, and that
- this situation was further aggravated by the often precipitous opening of domestic markets to imported goods and technology transfer in connection with the introduction of a market economy.

Under these conditions industrial R&D and applied research in particular, which were oriented to current or foreseeable concrete demand, ceased to be necessary to certain enterprises and therefore lost their (economic) legitimisation on the political plane. This sector was therefore heavily cut back in a very short time in all countries, and as production lines were dropped and technological trajectories were changed, this led to the devaluation of skills and experience in R&D. This process was only curbed when the economic

transformation was slow to run its course and the old structures were maintained longer (for example in the CIS countries, Romania, Vietnam), or when farsighted political actors attempted to save at least the best-performing core sector of this potential (e.g. in East Germany, Hungary, Poland). That was achieved mainly through the (partial) financing of applied research institutes through public funds, through the stipulation that in-house R&D departments be preserved in the course of privatisation, and through the promotion of spin-offs and other innovative firms. Government aid was meant to contribute to the overcoming of 'temporary market failure' caused by structural and functional ruptures during transformation. These efforts were successful to the extent that core areas of industrial R&D were maintained and contribute through innovation to economic renewal. But the expected 'climb out of the slump' and a renewed modest growth in demand for domestic R&D has been achieved only in exceptional cases (Hungary, Slovenia), because the transformation countries have lost their once predominant position in the S&T of the CMEA region, which was formerly assured to them by self-isolation and embargo. At least the smaller countries, now that they have for the most part opened up under conditions of economic globalisation, have usually become the 'extended work-benches' of multinational companies, having at best very limited R&D of their own.

c) The justification, dimensions and organisation of *basic research* have also often been held to question in the face of meagre public funds. But because they are 'part of national culture and tradition' and a matter of international prestige, there has never, even for sharp critics, been an alternative to the preservation of this research sector through public funding. But due to financial cutbacks and institutional and personal changes, it has often been more a case of bare „survival“, associated with overaging of staff and progressively deteriorating and internationally not competitive working conditions. The improvement of financial and infrastructural conditions is, however, imperative for the maintenance of and long-term increase in the performance of research. Not only the production of internationally respected research results depends on this, but also, among other things, international collaboration on a footing of equality (with mutual exchange of scientists)¹¹, ability to retain leading scientists in the country, recruitment of young scientists, the swift practical utilisation of results, etc. To

¹¹ There are no longer political or other formal barriers to international relations, but so far they are still very one sided and primarily geared towards scientists from transformation countries participation in conferences and (generally brief) working visits in Western nations (cf. Mirskaja, 1998).

date, there are considerable deficiencies in all countries in transition, which especially in connection with the recently appearing existing 'generation gap' among scientists now jeopardise the continuation even of internationally successful lines of research. The danger at hand here is less one of the devaluation of skills and experience possessed by present scientists, but rather one of the loss of their 'tacit knowledge' – which threatens to become irreversible – from research experience and of research results for international science as a result of the lack of continuity within the scientific workforce.

4.4 Summary

S&T in the transformation countries has in the past ten years undergone major changes on all planes, as simultaneously

- institutional corrections within the STS have taken place and
- the systemic changeover in the political and economic fields has also effected major changes to the size, structure and content of the domestic demand for scientific results and services, and
- in addition to that, the international opening-up to high-tech imports and other forms of technology transfer has further minimised the need for domestic R&D.

In the last ten years, the changing needs for instruction and research, most of them caused by factors extrinsic to science, have thereby exercised a determining influence on the fate of science and of the R&D personnel in the former socialist countries. Despite big shifts in the spectrum of scientific activities, only partial devaluation of knowledge and skills has taken place, and experience in research has actually proved invaluable in coping with new tasks inside and outside of scientific institutes. Younger scientists and the university graduates of the 90s have received and utilised a wide variety of new opportunities and paths of development due to their good professional and wide educational background – by beginning or continuing professional activity in science in a foreign country, by receiving employment in the domestic branch of a foreign enterprise that is well-paid and demands high skills, or by realising their plans to become self-employed, thus forming or augmenting a highly qualified core group of innovative entrepreneurs.

The shift in demand that is connected with the change of social system explains the fairly uniform basic tendencies for instruction to expand and R&D to be reduced, which exist in all

transformation countries; beyond that, however, there are also considerable differences in the course and extent of the reduction of R&D, which for their part are attributable either to a laissez-faire policy or to (more or less) active intervention by actors from the political, economic and scientific sectors. The crux of the matter was to cushion the structural ruptures by means of satisfactory transitional regulations, with rather more passive „survival strategies“ predominating on the one hand, and active adaptation to new conditions and future demands being sought after on the other. It is precisely the complexity of the social changes in the national and international framework, especially now that the ‘cold war’ has ended, that has made a new strategic orientation of S&T more difficult, its remodelling on new lines inappreciable and drawn out, and has led to partially contradictory results. Despite the consolidation of scientific institutions and substantial institutional innovation, the restructuring of S&T is not yet a closed chapter. Co-ordinated activity on the part of the political, economic and scientific sectors in order to establish effective national innovation systems that are suitably integrated into their economic region (whether Europe, around Russia or Southeast Asia) and into the world economy and world science, has usually just started. The results to this date lead to the expectation that there will be further differentiation between and within these countries, as the internationally observable trend toward regionalisation of innovative activities continues.

Consequently, it has been possible here to present only a provisional appraisal of the changes within S&T, their causes and the new challenges. Its assessment is that the reduction in demand for R&D, and not lack of ability to perform on the part of science and scientists, was the primary cause of R&D personnel reduction. This also means, however, that under new societal conditions the institutes and scientists are not always able and willing to continue with their former activity, especially in R&D. Therefore, the inherited institutional preconditions in science and research, along with individual knowledge and levels of educational attainment are not assets and advantages in and of themselves. They must constantly be seen in relation to the overall societal framework. To that extent they are *potential* preconditions that only take effect and turn into real assets when they are able to adapt to new social circumstances, or when they help to shape these circumstances, or when they contribute to the fulfilment of the ever-unfolding new needs, possibilities and demands of society. Accordingly, the fundamental question does not seem to be whether the capacities taken on from the socialist era are assets or liabilities. Instead, the problem seems to be one of how to employ, change and utilise the personnel and other capacities inherited from the

socialist era, with the abilities, skills, experiences etc. that it has, in such a way that it is able to meet the new demands, to cope with the challenges and to act as an asset!

The real lesson for science in modern societies to be gleaned from the experiences of former socialist countries is that it cannot stand outside of or alongside the development of society – a view which finds its theoretical expression especially in the concept of the ‘national systems of innovation’ (cp. Freeman, 1987; Edquist, 1997) or that of the ‘triple helix model’ of university-industry-government relations (cp. Etzkowitz and Leydesdorff, 1997). The situation of S&T in the economies of transition to this extent represents less an exception and more the regular event of constant restructuring that takes place in the relationship between science and society. Considering the profound nature of the changes, their rapid sequence in time and their simultaneity in several countries, which have developed and positioned themselves internationally in different ways, there is no doubt but what we are dealing with a (relatively rare) extreme situation of transformations in the relationship of science and society. The resulting opportunities for comparative international research on this phenomenon should be utilised more intensively by research on science in the future.

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P 93-401

Werner Meske

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P 93-402

Hansgünter Meyer

Neugestaltung der Hochschulen in Ostdeutschland - Szenarien - Friktionen - Optionen - Statistik

P 93-403

Werner Meske und Werner Rammert (Hg.)

Ein Blick auf die neue Wissenschaftslandschaft

Zur Lage der sozialwissenschaftlichen Wissenschafts- und Technikforschung in Ostdeutschland

P 94-401

Alexander Nadiraschwili

Die Transformation der Wissenschaft in den Ländern der ehemaligen UdSSR - Angaben zum Ressourceneinsatz als eine Ausgangsbedingung für die Transformation

P 94-402

Werner Meske

Veränderungen in den Verbindungen zwischen Wissenschaft und Produktion in Ostdeutschland

P 94-403

Marion Höppner

Problems of Integration of Newly Established Research Institutes in East Germany

P 94-404

Werner Meske

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P 95-401

Hansgünter Meyer

Die Paradoxien der Hochschulforschung und das Neugestaltungs-Syndrom

P 95-402

Annett Fedorko

Finanzierung der Wissenschaft in Osteuropa Ende der 80er, Anfang der 90er Jahre

P 95-403

Jochen Gläser, Charles Melis, Klaus Puls

Durch ostdeutsche WissenschaftlerInnen gegründete kleine und mittlere Unternehmen

P 95-404

Jochen Gläser, Gabriele Groß, Marion Höppner, Charles Melis, Werner Meske

Die aufgeschobene Integration - Erste Befunde zur Integration neugegründeter Blaue-Liste-Institute in die deutsche Wissenschaftslandschaft

P 96-401

Werner Meske, Dang Duy Thinh (Hg.)

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P 97-401

Jochen Gläser

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P 98-401

Grit Laudel, Jochen Gläser

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P 98-402

Jochen Gläser

Kognitive Neuorientierung der ostdeutschen außeruniversitären Grundlagenforschung als Folge des Institutionentransfers

P 98-403

Werner Meske

Institutional Transformation of S&T Systems in the European Economies in Transition- Comparative Analysis

P 99-401

Jochen Gläser, Grit Laudel

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P 99-402

Jochen Gläser, Grit Laudel

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P 00-401

Werner Meske, Dang Duy Thinh (Hg.)

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