EASST SPECIAL ISSUE

• *ABSTRACT*

The radical transformations in the former communist countries of Central and Eastern Europe (C&EE) have prompted a growing body of scholarship concerned to analyze both the dramatic decline and the de facto *restructuring of research systems throughout the region, and future opportunities for rebuilding them. This paper provides some basic background information on how science and technology (S&T) were organized before the transformations, and the changes since. It then briefly indicates why the topic is important for the field of science and technology studies (S&TS), and describes some trends in the development of S&TS in and on C&EE, before introducing the individual contributions in this Special Issue.*

Transformation of the Research Systems of Post-Communist Central and Eastern Europe: An Introduction

Katalin Balázs, Wendy Faulkner and Uwe Schimank

The profound changes which have taken place in the former communist countries of Central and Eastern Europe (C&EE) since 1989 have reshaped the institutional basis of scientific and technological research, as well as of other activities. The collapse of former markets, together with the broader economic crisis and stringency of government funding, have resulted in a dramatic decline in the size of the research system. This has been accompanied by structural changes, although the degree and timing of these changes differs from country to country. Industrial R&D has all but disappeared in many sectors, and the situation for those

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left working in the academies is now very insecure. The practice of research is also changing, as communist party control of research has been broken and opportunities for researchers to interact with the scientific community internationally have increased. What has not changed so far is the relative lack of interaction between research and industry. The very fluidity of the situation is prompting diverse responses, with many academicians seeking to protect basic research and some exploring new ways of working collaboratively with enterprises.

The papers collected in this Special Issue reflect a growing concern to investigate and analyze these changes. Our aim in bringing them together in this form is threefold. First, we sought to familiarize readers outside of C&EE with the current situation in different countries of the region, concerning both the decline in the research base and the range of responses to this. Second, in so far as this is possible in a fluid environment, we sought to analyze the factors shaping the transformation of the research systems — drawing, where relevant, on existing theory and scholarship in the field of science and technology studies (S&TS). Third, we hope that this Special Issue will stimulate and provide a springboard for the further development of scholarship on the research systems in post-communist Europe. So we have sought to 'shine a light' on the range of existing scholarship on the subject and, in the process, suggest areas for future research and policy development. Perhaps most importantly, we would stress our firm belief that in the area of S&TS there is much for the West to learn from the experiences and perspectives of the East, just as the East can learn from mistakes and failures in the West.

This Introduction is in four sections. The first provides some basic background information on the topic. It outlines how science and technology (S&T) were organized before the transformations, and provides an overview of the shrinking research base. The second briefly indicates why these developments are important for the field of S&TS, and the third describes some trends in the development of S&TS in the former communist countries of Europe. Finally, we outline briefly the individual contributions in this Special Issue. Our own conclusions on the implications of these articles for both policy and future research are presented as a Postscript to the collection.

Background

How Research Was Organized before the Transformations

There is a common structural heritage in the research systems of C&EE rooted in the shared past. The institutional complex developed in the USSR was introduced in the other countries, along with the common ideological belief in the political role of science in 'scientific socialism'. The design of this institutional complex followed the general principles of central planning: specialization, rationalization and centralization. It was organized in three sectors — the academies, the universities and the industrial or 'branch' sector — each with distinct functions and sharply separated from one another.

The National Academies of Sciences were designed to carry out basic research in research institutes of the main disciplines. Academicians were a small élite who achieved this status by passing four different research degrees,[1] and, to varying extents, by satisfying political masters. They were a kind of *nomenclatura* in that their salaries went up to the same levels as ministers and they enjoyed the same privileges (for example, chauffeur-driven cars, holiday homes). In the Soviet model, each academician was 'given' a research institute which he or she controlled (within the government plan and accounting rules).[2] This strict connection between individual academicians and institutes became a significant source of scientific conservatism. In a situation where funding went to institutes rather than individuals or research groups and institutes were rarely closed, it also led to a multiplying of institutes (see the paper by Gaponenko in this issue).[3]

The assemblies of the academies (on which all academicians sat) played a role like societies of honoured scientists and, at the same time, were responsible for science policy-making, coordinating basic research throughout the country. The two roles were overlapping and confusing — even conflicting. Academicians were not selected on the basis of managerial or policy-making skills. Outside the Soviet Union, the role of management moved away from them over time and the conflict between the managers and the assemblies for control over institutes became one of the most striking clashes during the transition (see, for example, the paper by Simeonova in this issue).[4]

The universities were initially devoted exclusively to education; they were not supposed to do any research. Higher education and research took place in separate institutions yet competed for the same budget — so an unhealthy rivalry developed between the two systems. In spite of poorer physical assets and funding, some research activity has developed in the university sector over time. For example, lecturers have worked on research degrees with their students. As a result of this activity, the level of university research cannot now be considered negligible in most countries.

Applied research and development was organized in industrial research institutes, which operated under the auspices of 'branch' ministries and according to the plan for the firms of the branch.[5] Industrial research was thus institutionally separate from the enterprises which, according to the tenets of central planning, were simply operational units whose sole role was to execute production plans. Some intra-firm R&D did reappear slowly on a small scale — in particular branches (like pharmaceuticals) or in response to the technical demands of production. But this institutional heritage is the main reason why the role of in-house R&D is still small in C&EE industry.

There were some similarities between central planning and the western innovation model of the post-war decades in that both systems were committed to large public investment in science as a leading force for the economy. However, the Soviet system is best understood as a linear model of *technical development* rather than innovation, since the role of marketing and business interests is largely absent. More significantly in terms of future innovation potential, each link in the linear model chain was institutionally separate — training, basic research, applied research and development, production — so the system as a whole was profoundly fragmented.[6] Communication both between different types of R&D, and between it and industry, was all supposed to be channelled through and orchestrated by the centre. The formality and centralized nature of this system was a major barrier to effective knowledge flows. In practice, technical development occurred because people found ways to get around these formal barriers. In all walks of life, central planning worked *in spite of* its inefficiency, because people developed elaborate ways of getting around the system — by finding back doors, exchanging favours and paying 'back-handers' — all of which relied on extensive

informal networks. S&T, too, functioned because people developed *informal* ways of communicating and getting things done.

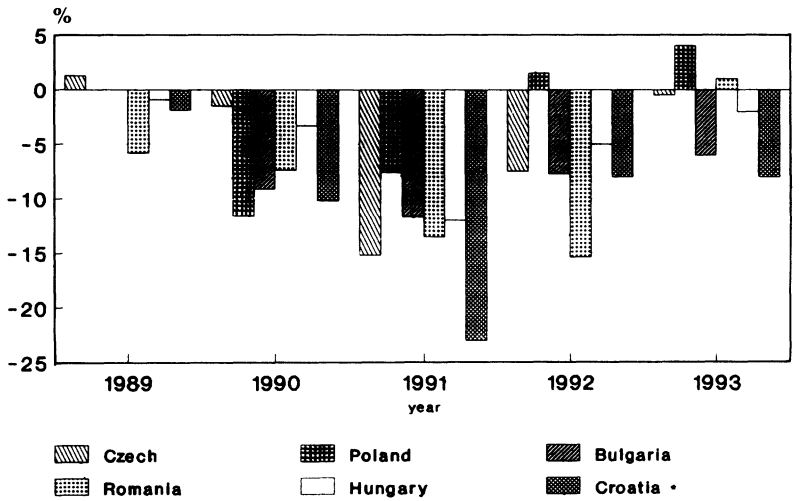
Quite apart from the demands of technical development or innovation, there are two widely acknowledged and general weaknesses in the research systems of C&EE — namely, the problem of 'ballast' or inefficiency, and the weakness of research evaluation. These features are due to the inherited practice for establishing and funding research institutes, which in turn partly explain why it has proved so difficult to set effective priorities for the research system during the transition period.

These general structural problems were similar across the region. However, due to economic and political changes over the last two decades, differences in the institutional framework emerged in the countries outside the USSR. In Hungary, following the introduction of a degree of market-type behaviour with business interests since 1968, industrial research institutes were transformed into state-owned R&D enterprises and contract research developed. In Czechoslovakia, the change in 1968 was in the opposite direction and the research system became once again strictly centralized and controlled. Polish economic problems led to political dictatorship, although central planning was slowly eroded. During the 1980s this, combined with falling living standards and public expenditure, led to an exodus of Polish intellectuals. Here and in Czechoslovakia and East Germany, growing pressure on research institutes due to falling funds led to some production-related and contract research. And in Romania, the 1980s saw Ceaucescu's 'crazy' period of extreme autarchy and a fully closed economy. Basic research was decried and the academy rendered insignificant, while industrial research institutes were strengthened in order to copy and adapt technology for import substitution.[7]

The Shrinking Research Base

The transformation in the research systems of C&EE was accompanied by deep economic crisis.[8] The effect of the political changes had been to break the formal economic links between these countries, which had previously traded through a complex series of exchanges reckoned in roubles. In a very short period of time, the requirement to trade in hard currency created a chain reaction

FIGURE 1
Growth of GDP



Sources: KOPINT-DATORG, op. cit. note 8 (Budapest, 1994); AIR Project Country Reports (Prague: CEU, 1993/94/95).
Note: *GSP only for Croatia.

from branch to branch and country to country, as companies found themselves unable to pay for goods and services received. Consequently, between 1989 and 1993, industrial production fell dramatically — by as much as 25–30% in the worst years. (This is reflected in the drop in GDP in Figure 1.) The crisis seems to be longer and deeper in the countries of the former Soviet Union.

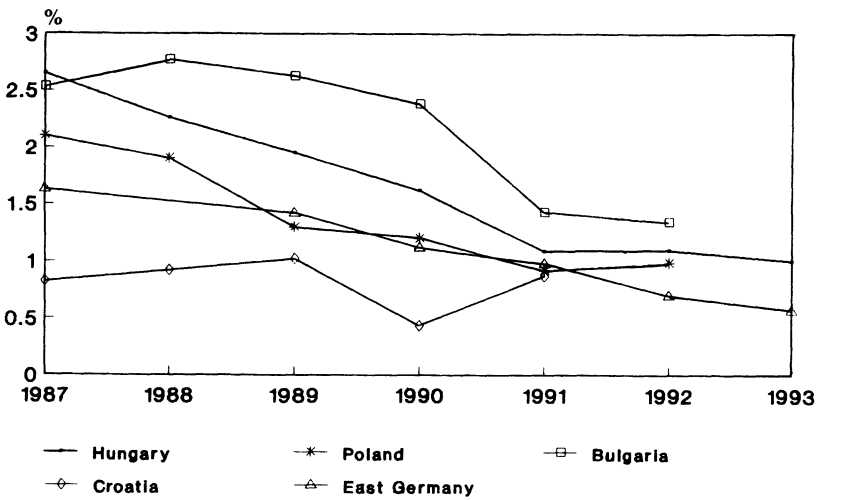
The central commitment of government policy for the transition has of course been to increase the size of the private sector through radical market liberalization — based on a simplistic belief that private property is more efficient than state property. (In general, the relationship between competition and efficiency is not widely understood.) Privatization programmes have taken a very particular form in C&EE.[9] In most countries, citizens have been issued with vouchers or coupons, as tokens of their 'public ownership' of state enterprises; many of these were fairly rapidly traded or sold for cash, which has resulted in a concentration of ownership and,

in some cases, the creation of near monopolies. Typically, the state retains a share in privatized enterprises (especially important large ones) through 'Investment Funds'.[10] In principle, this provides the basis for a more strategic approach, since the enterprise could contribute to future state revenue through taxes. But, in practice, governments have been primarily concerned with getting a good selling price rather than finding an owner with a good strategy for the business.

What this highlights is that liberalization policies have, in most countries, been combined with tight monetary policies and stabilization measures, geared to controlling inflation and balancing the state budget. These two strands have been uncoordinated and often in conflict. In particular, the emphasis on stabilization has in effect blocked any strategic view and reinforced the political tendency to short-termism. *De facto*, a primary government aim in privatization programmes has been to generate immediate income for the state rather than to build an industrial base that will be competitive (and tax paying) into the future. Another very serious result of stabilization and monetary policies is that interest rates have soared and investment has become very expensive. This has made it difficult for most individuals to benefit from the privatization programmes. It has also meant that many firms have faced bankruptcy or have been unable to expand their domestic markets due to lack of working capital — at a time when the domestic market has been opened to foreign imports, and the removal of price subsidies has made exporting more difficult. The transition has disrupted both the formal marketing and production links and the informal links which previously helped to get things done, since many of the actors have gone or changed.[11] This, coupled with the general uncertainty and capital shortage, means that firms, too, are concentrating on the short-term rather than taking a strategic view.

The economic crisis produced a dramatic decline in the resource base of the research system, both relatively and absolutely. The quantitative data presented in Figure 2 (showing expenditure on R&D as a percentage of GDP) are not equivalent to those collected in OECD countries,[12] but they give some indication of the extent of the decline. In general, the level of funding before the crisis was rather high — generally close to 3% of GDP during the 1960s and 1970s. The timing of dramatic change varied between countries,[13] but in all cases gross expenditure on R&D

FIGURE 2
GERD/GDP 1987–93 in EEu

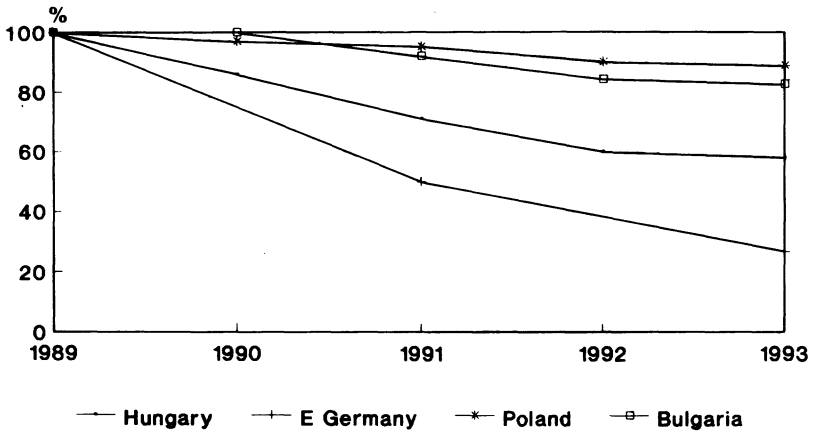


Sources: 'Tudományos K+F 1991' (Budapest: KSH, 1991); 'Selected Science Indicators of HAS' (Budapest: HAS, 1994); AIR Project Country Reports (Prague: CEU, 1993/94/95).

declined even as a proportion of the declining GDP — generally to below 1% in two to three years. In absolute terms, the reduction in size was as much as 50% in some countries.

The research system has undergone a number of passive structural changes as a result of the declining expenditure and changing economic environment. In particular, the industrial sector of the research system has declined more than the other two sectors, largely because industrial expenditure on research has declined even more than state expenditure. At the same time, government policies have viewed research as another problematic 'state heritage', part of the 'old' bureaucracy. Although some politicians have raised demands for more application-oriented R&D, there has yet to emerge in any country in the region a strategic view of the research system, and of how it might contribute to competitiveness — and, thus, to economic recovery. S&T policy making (such as it is) has been a contradictory process, shaped

FIGURE 3
Calculated Number of Scientists and Engineers (FTE) in EEu (1989=100%)



Sources: 'Selected Science Indicators of HAS' (Budapest: HAS, 1994); AIR Project Country Reports (Prague: CEU, 1993/94/95).

mostly by the in-built tensions between the universities and the academies, and between the different industrial branches — a rather weak basis for lobbying for a coordinated government strategy.

When research funding began to decline, many marketeers argued that this process would act to remove the ballast from the research system. This has not really occurred. Many of the most able scientists have moved to scientific posts overseas or to higher paid jobs in the growing private sector. (The decline in the scientific and technological workforce is presented in Figure 3.) The single most significant structural development in this regard has been the partial introduction of a contract research system with the establishment of National Research Funds and Technical Development Funds by governments,[14] and of the private Soros Foundation. Although this has created an element of individual or team-based (rather than institution-based) competition for research grants,[15] the research system as a whole has not yet embraced the need for evaluation based on quality selection or

economic utility. The uneven losses with regard to both individuals and institutes can, in these terms, be seen as irrational. As we and many of the authors in this Special Issue argue, a key requirement in the transformation of the research systems of C&EE is for priority setting and evaluation as the basis for achieving both efficiency and effectiveness.

Why the Topic is Important for the Field of S&TS

In addition to the global significance of the transformations in C&EE, and the particular relevance of the transformation of these countries' research systems due to their sheer size, the developments outlined above raise a number of issues which are interesting from the viewpoint of S&TS. The most obvious of these fall into two strands of scholarship in S&TS, of which the first concerns science as a social institution and is the focus of most work so far.

Perhaps uniquely, the changes in post-communist Europe provide an extreme case of how 'science' responds to wider political and economic change. Democracy and institutional restructuring are recurring themes, with calls for the removal of politics from the governance of science and (in the event less forcefully) for the downgrading of the national academies from their formerly dominant position in the research system. Ironically, while communist party control over research institutes has declined, the research community is finding it harder than in the past to influence the state favourably. The relationship between the research system and the political system is thus thrown into sharp relief. But all this is happening against an economic backcloth of dramatically reduced funds for research. The combined reduction and restructuring of the research system begs the questions 'Who have been the winners and losers?' — for instance, in terms of age, gender, region, types and fields of research and so on — and 'what has shaped this?'

The second strand of S&TS interest in the transformation of research in C&EE concerns how the research system contributes to the innovative capacity of these countries. Even allowing for the inefficiency in research institutions, and the difficulty of comparing R&D statistics from C&EE, these countries have typically had a comparatively high R&D capacity when considered in relation to the size of their GDP or industrial bases. This has prompted

economists to suggest that the existing research base may not be sustainable in the context of an open market economy.[16] There are also serious concerns about the emergence of functional links between industry and S&T. As we noted above, the particular course of industrialization in the communist countries did not involve the development of intra-firm R&D as it is known in the capitalist world; command economy management meant that formal communication and knowledge flows between research and industry were generally mediated by the centre. Now this system has broken down, and industrial funding of R&D has declined drastically. So there has been no 'demand pull' from the emerging private sector to replace the science and technology 'push' of state-funded R&D. All this raises interesting questions about what form emerging national systems of innovation in C&EE will take. Recent initiatives in the commercialization of research might provide some pointers.

The Development of S&TS in/on the Region

The development of the research systems in communist Europe attracted the attention of a small band of western scholars, from a range of disciplines, in the decades before the transformations.[17] *Within* the countries of C&EE there was already established scholarship in S&TS, but the history of the field in the region is rather particular. Technology was addressed only occasionally by economists — as an element in industrial development — or by engineers and managers as an element in the organization of production. Within science studies before the transformations, there were established traditions in the sociology of science (mainly scientometrics and institutional studies of science), and in the history and philosophy of science, but there was no real development of a wider sociology of science (for example, controversy studies), or of a sociology of scientific knowledge[18] — presumably because of an ideological resistance toward the post-Kuhnian, relativist turn in western science studies.[19]

Needless to say, the current crisis has prompted a growing interest in studying what is happening to the institutions of S&T in the region. In particular, two networks have brought scholars in C&EE together to try to measure and analyze the changes.[20] One, initiated for the German government by Renate Mayntz and Peter

Weingart, and coordinated by Uwe Schimank, 'Transformation of Science Systems in C&EE', has so far sought to document the decline and rebuilding of the research system.[21] Another, coordinated by Katalin Balázs and Andrew Webster with funding from the Central European University (in Prague) and the European Commission, is a comparative study entitled 'The Innovation Potential in Changing Academic–Industry Relations' (the 'AIR Project'), which has explored responses to that decline, especially responses which seek to build bridges between research and industry.[22] The 1994 EASST conference held in Budapest was a valuable opportunity for this and related work to be presented to a wider audience; it saw some 50 participants and nearly as many contributions from the post-communist countries of C&EE, including the former Soviet republics. This Special Issue was drawn from these efforts, and thus provides a reasonable reflection of the current development of this scholarship.

Of necessity, the initial thrust of this research has been to document the nature and extent of the crisis and the decline in the research system: things have moved fast and there is a real need for concerted information gathering, especially on a cross-nationally comparative basis. Analysis has followed more slowly. For researchers who have grown up in a strongly ordered (and largely orderly) society, the changes in the research system are typically experienced as chaotic. Nevertheless, the desire to make sense of and explain these changes is beginning to be reflected in the development of a search for theory.

This task is problematic, for two very good reasons. First, western analytical frameworks are not necessarily appropriate or applicable to the specific historic conditions of C&EE. While Easterners and many policy advisers none the less gravitate towards western models, these are often idealized by those who have not grown up in capitalist countries. The second problem is almost the converse of this — namely, that much of the knowledge necessary to make sense of the transformations taking place in C&EE is embedded in the lived experiences and heritage of the peoples of that region (for example, how people learn to get around the bureaucracy). Like other forms of tacit knowledge, such knowledge is obvious to its holders but not readily available to outsiders.

This latter difficulty was revealed to us in the course of putting this Special Issue together. Time and again, in order to make sense

of particular evidence or assumptions in the papers we commissioned, the two West Europeans in the group found themselves having to ask quite basic questions, not only about the organization of S&T but also about life in C&EE society, more widely — either we simply didn't know or our impressions were simplistic (if not wrong). The East European in the group found herself having to explain things which she (naturally) took for granted, and in the process often came to reflect on them in a new light. The involvement of both West and East Europeans in the editorial group has thus proved very fertile, although the process was by no means straightforward — we often found ourselves talking at cross purposes. Gradually our deliberations clarified the similarities and differences in the experiences of the two regions, and suggested common institutional and conceptual reference points for analyzing these similarities and differences. Indeed, the process has highlighted for us just how profound has been the divide between East and West during the Cold War years, and just how great is the need now for mutual awareness and understanding.

There were other differences of perspective within the editorial group which proved to be useful sources of creative tension. The group included one economist, one sociologist and one 'hybrid' sitting somewhere between these poles. The primary focus of one was on science, while the other two were more oriented to the relationship between science and technology. These differences meant that we diverged somewhat in the conceptual frameworks, languages and assumptions we brought to the subject, and in our perceptions of what was important and why. While we were all concerned to develop an analysis of the current transformations, we differed in the degree to which we sought to do this primarily to extend a general understanding of S&T, or to generate prescriptive conclusions specific to C&EE. And our conclusions about policy differed, notably in the emphasis we would place on preserving basic research. In these respects, we represented a microcosm of the field — both of S&TS internationally and of the debates surrounding S&T policy in C&EE.

Structure of this Special Issue

The papers collected in this Special Issue reflect the bulk of work so far on the transformations of the research systems of C&EE,

which brings with it an unevenness of coverage. The primary focus is on the academic research system, more than higher education or industrial R&D, which tends to give undue emphasis to basic research and a 'science push' perspective on S&T policy. And there are two obvious gaps: there is no work on military or space S&T — for reasons of secrecy — and none on gender — for reasons of neglect!

The first two papers in the collection offer 'overviews' which seek to summarize and explain developments, while the remaining papers (all taken from the EASST conference) investigate, with reference to specific cases and settings, important general aspects of the transformations. Our own postscript, 'Science and Technology Studies and Policy in Central and Eastern Europe: What Next?', reviews the implications of this work for future S&T policy and S&TS research.

Of the overview papers, 'Transformation of Research Systems in Central and Eastern Europe: A Coincidence of Opportunities and Trouble', by Uwe Schimank analyzes the general pattern of conflicting opportunities, demands and restrictions currently shaping the transformation of the research systems in the region. He argues that this cumulation of factors has led to its, so far, unsatisfactory outcomes. The paper by Katalin Balázs, 'Innovation Potential Embodied in the Research Organizations of Central and Eastern Europe', has a complementary focus; it looks more to future potential than past decline. Out of the various adjustments which researchers are making in order to survive, are emerging, 'bottom-up', new associations and business-oriented initiatives. She argues that these involve recombinations of (old and new) knowledge, skills and contacts, which are forming important bridges between research institutions and industry, and so could contribute significantly to emerging new systems of innovation.

The following two papers explore the case of Russia, which was more extreme before the transformation, and is more extreme now, than the other countries of C&EE. In 'Transformation of the Research System in a Transitional Society: The Case of Russia', Nadezhda Gaponenko describes the critical legacy of the Soviet organization of research. She documents the strongly destructive tendencies currently underway, but suggests that there are at least some signs of hope. This contradictory picture is underlined in Elena Mirskaya's 'Russian Academic Science Today: Its Societal Standing and the Situation Within the Scientific Community'. It

presents cultural insights into traditionalist perceptions of science in Russian society, plus survey results on Russian academic scientists' attitudes to the recent changes in the research system, which are somewhat less despairing than one might expect.

The next two papers stay with the scientific community, especially those in the academies. In 'Changes in the Management and Finance of the Research System in Poland: A Survey of the Opinions of Grant Applicants', Julita Jablecka throws light on a crucial element of institutional rebuilding in Polish S&T: the installation of a grant system of research funding. Her survey results show that most Polish grant applicants are in favour of the new competitive funding system. In complete contrast, the resistance of Bulgarian academic scientists to efforts to privatize research and encourage spin-off companies has been more extreme than elsewhere. As Kostadinka Simeonova documents in 'Radical and Defensive Strategies in the Democratization of the Bulgarian Academy of Sciences', this conservatism coexists with radical measures to remove communist influence in the Academy.

The next two papers look at changes in other research sectors. In 'Industrial Research in Hungary: A Victim of Structural Change', Judith Mosoni-Fried paints a depressing picture about the fate of the industrial R&D sector, which has declined by 70% in Hungary. Privatization has transformed most remaining industrial R&D institutes into small firms, very few of whom are capable of (or interested in) technological development. 'Changes on the "Borderlines" between Research and Industry following Economic Transformation in the Czech Republic', by Karel Müller, addresses the various enterprising activities by which institutes in the academy, industry and university sectors have sought to defend their research capabilities. He concludes that liberalization, plus inherited structural features of the research system, have both created opportunities for, and place constraints on, creative links emerging between research and industry.

The final papers in this collection examine two very different cases of how changing relationships between relatively small countries and their more powerful neighbours are shaping S&T policy. In 'An Academy in Transition: Organizational Success and Failure in the Process of German Unification', Hans-Georg Wolf looks at the mixed fate of institutes in the GDR's Academy of Sciences when it was dissolved in 1990 as a result of German unification. In contrast to the wide sense of impotence amongst

researchers in C&EE, his study shows that, under certain circumstances, institutes or research groups have had a chance to influence what happened to them. The break-up of the former Soviet Union presents almost the converse situation to German unification. In 'Changing Centre–Periphery Relations in the Former Soviet Republics: The Case of Belarus', Gennady Nesvetailov considers the position of the now independent state of Belarus, as a peripheral country which is to a degree reorienting towards the West while facing mounting pressure for re-integration with Russia. The options for S&T policy in Belarus seem limited indeed, given extremely limited resources, but lessons are usefully drawn from the experience of Finland, a major significant difference being its longer tradition of sovereignty.

• NOTES

We would like to acknowledge our warm thanks for the very professional editorial support of David Edge, who steered us almost painlessly through the process of putting together this Special Issue in limited time. The very topic of the Special Issue put unusual demands on him in finding appropriate assessors and referees for the material we collected. We are particularly grateful for his thoroughness in drawing to our attention many related publications cited in the notes below.

1. These degrees were: Doctor of University, Candidatura, Doctor of Science, and Appointee to the Academy. Researchers were paid, from the central state budget, a supplement on their salary for each of these degrees.
2. Resources simply did not allow for so many institutes to be set up in the smaller countries.
3. Nadezhda Gaponenko, 'Transformation of the Research System in a Transitional Society: The Case of Russia', *Social Studies of Science*, Vol. 25, No. 4 (November 1995), 685–703.
4. Kostadinka Simeonova, 'Radical and Defensive Strategies in the Democratization of the Bulgarian Academy of Sciences', *Social Studies of Science*, Vol. 25, No. 4 (November 1995), 755–75.
5. In the 1950s, industrial branches each acquired their own ministries.
6. G. Darvas, *Science and Technology in Eastern Europe* (London: Longmans, 1988); K. Balázs, 'Market-Oriented Scientific Research and Development after the Economic Reform', *Acta Oeconomica*, Vol. 39, Nos. 3–4 (1988), 271–90.
7. Ileana Ionescu-Sisesti, 'Restructuring Science in the Public Sector: A Case Study of Reform of National Research in Romania' (Washington, DC: George Washington University, mimeo, 1994); Steliana Sandu, 'R&D Institutes in Romania', Case Study (CEU AIR Project, mimeo, 1994).

8. Statistical data on this is collected in *KOPINT-ATOR, Economic Trends in Eastern Europe* (Vienna & New York: Springer-Verlag, several issues from 1992).

9. Privatization programmes have proceeded to varying degrees. In Bulgaria the programme has virtually ground to a halt due to lack of popularity.

10. We use the term 'investment funds' generically to refer to a range of similar organizations – 'State Property Funds', 'State Share Holder Companies', and so on. These organizations own the state property, and are responsible for privatization and property management. Their role and structure have been frequently changed: see, for example, Éva Voszka, 'Az agyaglábakon álló óriás: Az Állami Vagyonkezelő RT felállítása és működése' (A Giant with Clay Legs: The State Property Holding's Foundation and Generation') (Budapest: Pénzügykutató RT, 1995). Most large firms are only partly privatized, and the investment fund retains 25% to 50% of the shares. There are different regulations and policies, according to firm size, sector and country.

11. See Wim Swaan, 'Behavioural Constraints and the Creation of Markets in Post-Socialist Economies', paper presented to the EACES conference (Trento, Italy, March 1994).

12. The most striking difference is that in the former communist countries, R&D was measured in terms of the size of R&D organizations—including all support staff—rather than in terms of the numbers of personnel directly working on R&D. These statistics therefore tend to overstate the size of R&D when compared with those of OECD countries. See Christopher Freeman, *The Economics of Industrial Innovation* (London: Pinter, rev. edn, 1982), appendix.

13. In Czechoslovakia, it was still high (over 3% GDP) until 1989 and has been declining rapidly since then. See OECD, *Review of National Science and Technology Policy: Czech and Slovak Federal Republic* (Paris: OECD, 1992), 46–48, figs. 11–14. In Hungary, the decline started in the 1980s (and had already prompted structural adjustments) although it worsened after 1989.

14. Through the Technical Development Funds, firms make a tax-free contribution for R&D projects, though in practice the money has often flowed to other activities. For Romania, see I. Ionescu-Sizesti, 'Transition and Conversion toward Innovation in Romania: Factors and Actions', presented to the IACHEI Annual Conference, 22–25 September 1992. For Bulgaria, see K. Simeonova, 'Reforms at Bulgarian Academy of Sciences and their Impact on Academic-industry Relations' (mimeo, 1993). For Hungary see: Balázs, op.cit. note 6; and K. Balázs, P. Hare and R. Oakey, 'The Management of R&D in Hungary at the End of the 1980s', *Soviet Studies*, Vol. 42 (1990), 723–41. Note that the Hungarian fund has been operating for nearly 30 years.

15. Because of the small scale of the funds available for contract research.

16. For a full theoretical and empirical assessment of this, see Slavo Radosevic, 'Eastern European Science and Technology Capabilities During the Transition: A Provisional Assessment of Effects and Prospects', paper presented to the Conference on 'The Role of Science and Technology Policy in Economic Transformation Programs, with Particular Regard to East-Central Europe and the Former Soviet Union' (Lyon, 10–11 December 1993) (Science Policy Research Unit, Brighton, Sussex, UK, mimeo).

17. Most of the relevant western literature focuses on the Soviet research system. See, for example, Kendall E. Bailes, *Technology and Society under Lenin and Stalin* (Princeton, NJ: Princeton University Press, 1978); Bailes, *Science and Russian Culture in an Age of Revolutions* (Bloomington, IN: Indiana University

Press, 1990); Harley D. Balzer, *Soviet Science on the Edge of Reform* (Boulder, CO, San Francisco, CA & London: Westview Press, 1989); Stephen Fortescue, *The Communist Party and Soviet Science* (Baltimore, MD: The Johns Hopkins University Press, 1986); Fortescue, *Science Policy in the Soviet Union* (New York: Routledge, 1990); Loren R. Graham, *The Soviet Academy of Sciences and the Communist Party 1927–1932* (Princeton, NJ: Princeton University Press, 1967); Graham (ed.), *Science and the Soviet Social Order* (Cambridge, MA: Harvard University Press, 1990); Graham, 'Big Science in the Last Years of the Big Soviet Union', *Osiris*, Vol. 7 (1992), 49–71; Graham, *Science in Russia and the Soviet Union: A Short History* (Cambridge: Cambridge University Press, 1993); David Holloway, 'Innovation in Science: The Case of Cybernetics in the Soviet Union', *Science Studies*, Vol. 4 (1974), 299–337; Holloway, 'The Politics of Soviet Science and Technology' (Essay Review), *Social Studies of Science*, Vol. 11 (1981), 259–74; Raymond Hutchings, *Soviet Science, Technology Design: Interaction and Convergence* (London: Oxford University Press, 1976); Paul R. Josephson, 'Science Policy in the Soviet Union, 1917–1927', *Minerva*, Vol. 26 (1988), 342–69; Josephson, *Physics and Politics in Revolutionary Russia* (Berkeley, CA: University of California Press, 1991); Josephson, 'Soviet Scientists and the State: Politics, Ideology, and Fundamental Research from Stalin to Gorbachev', *Social Research*, Vol. 59 (1992), 589–614; Linda L. Lubrano and Susan Gross Solomon (eds), *The Social Context of Soviet Science* (Boulder, CO: Westview Press; Folkestone, Kent: Dawson, 1980); Lubrano, 'The Hidden Structure of Soviet Science', *Science, Technology, & Human Values*, Vol. 18, No. 2 (Spring 1993), 147–75; Robert F. Miller, 'The Role of the Communist Party in Soviet Research and Development', *Soviet Studies*, Vol. 37, No. 1 (January 1985), 31–59; Roald Z. Sagdeev, *The Making of a Soviet Scientist* (New York: Wiley, 1994); Thomas Schott, 'Soviet Science in the Scientific World System', *Knowledge: Creation, Diffusion, Utilization*, Vol. 13, No. 4 (1992), 410–39; Eugene Zaleski et al., *Science Policy in the USSR* (Paris: OECD, 1969). Only a small literature has considered the research systems of C&EE in the context of industrial innovation: see Ronald Amann and Julian Cooper (eds), *Industrial Innovation in the Soviet Union* (New Haven, CT: Yale University Press, 1982); Joseph Berliner, *The Innovation Decision in Soviet Industry* (Cambridge, MA: MIT Press, 1976); Philip Hanson and Keith Pavitt, *The Comparative Economics of Research, Development and Innovation in East and West: A Survey* (Churr, Switzerland: Harwood, 1987).

18. The development and character of sociology in the region is varied. The sociology of science took root in the Soviet Union during the mid-1960s, influenced by earlier work in Poland. The discipline of sociology was well established in Poland, whereas economics there was viewed as suspicious by the communist authorities. In Hungary, the situation was the opposite, with sociology viewed as suspicious.

19. For analyses of the field (mostly from within C&EE), see G.M. Dobrov, 'The Sociology of Science in the USSR', in Robert K. Merton and Jerry Gaston (eds), *The Sociology of Science in Europe* (Carbondale & Edwardsville, IL: Southern Illinois University Press, 1977), 316–34; Paul R. Josephson, 'Soviet Historians and *The Structure of Scientific Revolutions*', *Isis*, Vol. 76 (1985), 551–59; S. Kachaunov and K. Simeonova, 'Social Studies of Science in Bulgaria', *Social Studies of Science*, Vol. 9 (1979), 91–99; T. Krauze et al., 'The Sociology of Science in Poland', in Merton & Gaston (eds), op. cit., 193–223; Alexey Levin, 'Soviet Science Studies: A Dissident View', (Essay Review), *Social Studies of Science*, Vol.

14 (1984), 451–67; Linda L. Lubrano, *Soviet Sociology of Science* (Columbus, OH: American Association for the Advancement of Slavic Studies, 1976); Vojin Milić, 'The Science of Science and the Sociology of Science in European Socialist Countries', *Current Sociology*, Vol. 28, No. 3 (Winter 1980), 185–342; E.M. Mirsky, 'Science Studies in the USSR (History, Problems, Prospects)', *Science Studies*, Vol. 2 (1972), 282–94; S. Szalai and J. Farkas, 'Sociology of Science and Research on Research', *Sociology in Hungary: Recent Issues and Trends, Szociológia* (1974), No. 5, supplement, 105–10; B. Walentynowicz, 'The Science of Science in Poland: Present State and Prospects of Development', *Social Studies of Science*, Vol. 5 (1975), 213–22.

20. There has, of course, been other work on the changes not covered by these two networks. Many items, written in Russian, are cited in the contributing papers of this Special Issue. For contributors in English, see also Jane Cave and Mark S. Frankel, *Breaking from the Past: Setting New Ground Rules for Scientific Freedom and Responsibility in East-Central Europe and the Russian Federation* (Washington, DC: Directorate for Science and Policy Programs, American Association for the Advancement of Science, September 1992); Stephen Fortescue, 'The Russian Academy of Sciences and the Soviet Academy of Sciences: Continuity or Disjunction?', *Minerva*, Vol. 30 (Winter 1992), 459–78; Paul R. Josephson, 'Russian Scientific Institutions: Internationalisation, Democracy and Dispersion', *Minerva*, Vol. 32, No. 1 (Spring 1994), 1–24; Yakov M. Rabkin and Elena Z. Mirskaya, 'Science and Scientists in Post-Soviet Disunion', *Social Science Information*, Vol. 32 (1993), 553–79. For a useful but mainly descriptive recent survey, see the section on 'Science in Europe '94: Storm Clouds over Russian Science', in *Science*, Vol. 264 (27 May 1994), 1262–82, esp. James D. Watson and Gerson S. Sher, 'Does Research in the Former Soviet Union Have a Future?', 1280–81. Over the past three years, *Nature* has regularly published information about Russian Science (mainly in its 'News' Section), and one relevant Editorial: 'Is There a Future for Russian Science', *Nature*, Vol. 365 (7 October 1993), 475–76.

21. The researchers in this network were: Kostadinka Simeonova in Bulgaria, Györgi Darvas in Hungaria, Gheorge Zaman in Romania, Eduard Samir in Slovakia, Jaan Laas in Estonia, Ina Dagyte in Lithuania, Janis Kristapsons in Latvia, Boris Malitsky and Alexander Nadiraschwili in the Ukraine, Levan Mindeli and Elena Mirskaya in Russia, Gennady Nesvetailov in Belarus, Julita Jablecka-Gebka in Poland, Petr Machleidt in the Czech Republic; Renate Mayntz, Uwe Schimank and Peter Weingart were the coordinators in Germany.

22. The researchers in this network were: Zoltan Andrási and Katalin Balázs in Hungary, Andrei Jasinksi in Poland, Mira Lenardic and Slavo Radosevic in Croatia, Werner Meske in Germany, Karel Müller in the Czech Republic, Steliana Sandu and Carmen Vlaicu in Romania, and Kostadinka Simeonova in Bulgaria.

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experience in the changing R&D systems, and the East–West comparison of academy-industry relations. Her latest papers on these issues include 'Lessons from an Economy with Limited Market Functions: R&D in Hungary in the 1980s', *Research Policy*, Vol. 22 (1993), 537–52; (with Ary Plonski), 'Academy-Industry Relations in the Middle Income Countries: East Europe and Ibero-America', *Science and Public Policy*, Vol. 21, No. 2 (April 1994), 109–117; 'Transition Crisis in the Hungarian R&D Sector', *Economic Systems*, Vol. 18, No. 3 (September 1994), 281–306.

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