Science, Technology and Education in the Context of Transformation in the Czech Republic

KAREL MÜLLER*
Institute of Learning Foundations, Charles University, Prague

Abstract: The article deals with the problems of transformation of science, technology and education (S&T&E) institutions in the environment of economic reform and political change in the Czech Republic (CR). It is based on empirical studies which were oriented at the assessment of changes in the innovation resources of industries, of research capacities in the technological, educational and public frameworks and of problems in the national education system. It attempts to embrace the institutional change not only in its organisational and resource patterns but also in its communicative and orientation potential. Within this cognitive perspective the research results indicate that the liberalisation of the state regulatory system and the strategy of radical economic reform could deconstruct the existing malpractice and mobilise activities with short term effects, but fail to produce new orientation, communication and networking patterns. On the contrary, the reform aims to face the resistance promoted by the rigid sectoralisation of S&T&E as shaped by centralistic regulatory practices, an absence of inter-institutional mediation and by the push of existing productive (research and teaching) structures. The identified structural dependencies of the transformation process are examined from two perspectives. The first attempts to explain their shaping in modernity's push against the autocratic power system in the context of post-war developments in the CR. The notion of reversed modernity is introduced in order to understand both the situation and perspectives of the transformation process within the framework of the present structuration of modern societies. The second perspective attempts to suggest a political approach and measures which will accommodate the transformation of S&T&E within the present economic and political situation as well as the change it may undergo.
Czech Sociological Review, 1994, Vol. 2 (No. 1: 53-69)

1. The conceptual framework of the study

The aim of this article is to contribute to the discussion on the problems of the transformation in the Central and Eastern Europe countries with respect to the role of the available capacities of science, technology, education (S&T&E) and to the changes in their institutions. The analytical background of the article is based on research the assessment of which intends to suggest measures which could promote the transformation of the institutions in the Czech Republic towards the prevailing regulatory practices in the innovation-oriented, democratic societies of Western Europe.[1]

*) Direct all correspondence to Dipl. Ing. Karel Müller, CSc., Institute of Learning Foundations Charles University, Legerova 63, 120 00 Praha 2 or Střední 974, 252 18 Černošice.

[1]) The research was supported by the grant of the Commission of European Communities „East Central Europe 2000"; the results are published in [Illner (ed.) 1993].

Accordingly, the comparative analysis method has been adopted,[2] being focused on the meso-level of the institutions of production (and their technological background), research (and their distribution by sectors) and education (and of HE in particular). The study follows a „structuralist" approach and avails itself of the evolutionary, historical context. Such an approach runs the risk of failing to identify niches of positive change which may be decisive for institutional change. For this reason the research also comprised expert studies in the selected areas, the aim of which was to describe the barriers, tensions and options of the action at the organisational level and as well as the strategies applied by the key actors.

The assessment of the institutions of S&T&E in a transitional period can only be successful through careful conceptual framing. Such a framework must embrace at least two issues: the growth of functional capabilities (of research, production and teaching) as related to their communicative (evaluative) and organisational patterns; the relationship between scientific, production and educational institutions and their direct or interactive impact on research growth and its orientation. The latter issue also concerns the realm of public policy - of regulatory practices in the fields of S&T&E and public acceptance of these expert and intellectual capacities within existing cultural patterns.

Given that the available concepts are a means of understanding the transformation process in the Central and Eastern Europe countries, relatively little attention has been paid to the issues of scientific, technological and educational power and their role in the transformation process. The prevailing economic concepts presume correctly that in the environment of a monopolistic regulatory regime the capabilities of science, innovation and education are separated from the pull of demand and that the re-establishment of market structures plays a decisive role in their recovery. The promotion of the pull of demand seems to be a correct strategy in view of the corrections of one-sided, push-oriented S&T&E capabilities as shaped in the environment of a monopolistic regulatory regime. But such a concept risks engendering a simplified assessment of S&T infrastructure, its cumulative and interactive nature and cultural background. Namely, it views technology as a sum of artefacts, any of which may be isolated by selective economic pressure and moulded by market assessment as socially viable. Technology is then assessed as socially neutral. The S&T Studies, and in particular the extensive assessment of the social implications of modern technology,[3] indicate that the power of both science and technology eventually escapes the control of market institutions, not only because it produces serious externalities but also because it becomes entrenched and embedded in socio-cultural structures [Bijker, Law 1992; Rip 1990]. Any regulatory policy (and political representation) with the capacity neither to understand the social and cultural relevance of technology nor to face the technology push with political and social

[2]) The comparative perspective refers to the concepts of de-institutionalisation and re-institutionalisation as shaped by the reflections of institutional changes in the Western countries since the 1970s. The analytical data are taken mostly from OECD studies including [*Review* 1992].

[3]) The understanding of such a shift in the social and cultural role of technology requires a revision of its definition which itself is a cultural mission, „black boxed" as it is by formal and informal learning curricula and cultural patterns of expert power. Such communicative barriers will play an important role in the post-communist environment's shortage of communicative infrastructures and of the consolidated economic and social background.

mobilisation loses both its democratic framework and competence since decision-making occurrs elsewhere.

Of course, the capacity to balance the push of technology with successful political action and socio-cultural response is a result of the evolutionary adjustments among the economic, political and cultural institutions, which balance the growth of regulatory power (of both the economy and the state) with a cultural one. However, (post-industrial) technology dynamics and their economic and political implications clash with such a regulatory framework, thus overloading the cultural instances with new challenges. The lack of responsive cultural (symbolic) power becomes the limiting factor of balanced social dynamics. H. Jonas pointedly explains that technology has assumed a central position, not only in the growth of our instrumental capabilities but also in the formation of our subjective expectations. Its push reveals the limits of our institutional arrangements and burdens any of our action with tremendous responsibility and ethical claims [Jonas 1984]. In this sense Western culture is a *technological culture*. Any technological design in this environment has essential social and cultural implications and any social or cultural design is mediated by technology [Schwarz 1993].

Historically, the innovative power of technology grew out of science's push and the regulatory role of both the market and of political institutions which had been exploiting mostly their systematic and instrumental power with its universalising implications. Such a framework forms an important part of the technological culture which can be designated as *techno-science*, or a period of primary modernisation [Beck 1986]. In such a technological environment the political agendas were framed by the issues of research growth, knowledge transfer, technology transfer, technology race, technological edges, normative education, production growth, consumption growth, effective bureaucracy and so on. The last decades have witnessed a new aspect in the basic issues of the political agenda for the technological environment: research growth and orientation, technology assessment, formative education, greening industry, smart bureaucracy, intelligent consumption, social mobilisation etc. - the other, now more visible side of technological culture, which could be called *techno-economic* or *socio-technical*, is emerging. There have been extensive discussions concerning how we are to understand and influence the growth of these countervailing parts of technological culture. Various social designs are sought and new risks identified. However, the political and social mobilisation and networking challenged by the changing technological environment, the awareness of both its cultural overloads and the options for legitimate action and the search for new regulatory practices seem to be of crucial importance to the control of technology. The persistence of political agendas from the period of techno-science is counterproductive to the new situation: it creates social exclusion and alienation and undermines the process of social inclusion and participation, without which new cultural agendas and public learning cannot grow.

An effective technology policy for an environment of technological culture is raising some essential questions: how can the technology push and its social entrenchment, producing technological regimes and social irreversibilities, be balanced with cognitive democratic policy, which mobilises the techno-economic and social actors and their networking in favour of democratic authority [Rip 1989]; how can the democratic political institutions escape the trap of becoming instances of a sub-policy which is driven by the unexpected (de-legitimising) implications of technological power

and which thus loses its competence (and credibility) in shaping social expectations and collective aims?

An outline of the evolutionary developments and structural shifts within the modern democratic societies offers a conceptual framework for a comparative assessment of the structural implications of developments in the former socialist countries. From the above-mentioned perspective, they followed the modern path of developments in the sense that they attempted to achieve social and cultural aims by mobilising techno-science. In the name of scientific rationalisation, institutions operating in accordance with competitive and communicative economic and political rationalisation were dissolved. Such a step dismantled the civilising framework of the distribution (and control) of power and opened the way for voluntaristic developments. In the Czechoslovak context such voluntaristic orientation it was possible to follow until the end of the 1950s, as the state was able to exploit the comparative advantage of existing technologies and thus substitute the waning ideological resources with consumption-orientated expectations. After the economic and political collapse in the 1960s such resources were exhausted. Along with the de-centration of the autocratic system, functional (and repressive) considerations began to prevail. The economic and state institutions expanded according to their technical aims without, however, discovering their implication for the cultural and moral (public knowledge-oriented) institutions. The cultural institutions - scientific, professional and educational - were marginalised, lacking public and communicative arenas. New socio-cultural settings were formed alongside the functions of institutions, with their links to the autocratic power centre forcing the traditional inter-institutional communicative links into the realm of informal communication and contracting. The social system was *de-centred into a set of sectors* representing a specific mixture of functional and local (mostly regional and private) aims. The cumulative and interactive capacities of the national technological culture were limited to an informal networking within the fragmented field of techno-science which was far-removed from socio-economic or cultural considerations. Social structuring also stagnated, remaining on a static traditional setting distant from meritocratic and innovative challenges. The modernisation efforts have resulted in a *reversed modernity*, distancing the S&T&E institutions from economic and public issues.

The following analysis will attempt to examine the nature of such sectoralisation within the *national technological infrastructure*. In particular, attention will focus on the analysis of *production research*, *education research* as well as *research in other public services and practical areas*. Further specific consideration will centre on an analysis of the interfaces of S&T&E institutions, as well as the impact of legitimate *market*, *state* and *other cultural (moralising) institutions'* power structures on the social system of research and science. Re-emerging competitive forms of public policy and the rapidly advancing privatisation enable an assessment of both the nature of the challenge issued to the sectoral social setting by the new power structuralisation, and the manner in which de-institutionalisation can be accompanied by the formation of a new institutional setting. For this purpose social studies on inter-institutional penetration, on the role of intermediary communicative organisations [Munch 1991] and on the shaping border lines between the social system of research and the social system of science [Krohn, Kueppers 1987] are of productive analytical value.

2. A brief outline of the Czech technological structure in the pre-socialist era

Historically, the Czech lands have been noted for their well-developed industrial technologies, a result not only of the skilled workforce and organisational capabilities but also of their responsive connections to scientific and educational institutions. The inherited industrial capacities (shaped by the industrialisation process within the Austria-Hungarian Empire) exerted an excessive push upon the national resources. However, the technical (and organisational) capacities and skills were responsive enough to cope with international competition, to make good use of international co-operation and to adjust to cyclic market conditions (especially the boom cycles in military and civilian production); the production structure was extensive, covering the primary and secondary sector industries, the consumer and machinery industries in particular. Research institutions were mostly located within the university system but some of them started to grow within industrial and governmental sectors. Their well-established contacts to world science centres (in particular to Germany) as well as to the national industries helped to balance their orientation with the aims of scientific excellence and of practical relevance. The cultural position of science was supported by a diversified education system, by the administrative competencies and political responsibilities of state; the diversified intellectual capabilities (shaped by technical and humanitarian visions, supported by relevant cognitive cultures and by elites in the political, entrepreneurial, academic as well as other cultural spheres) played a positive role in the growth and orientation of the national S&T capabilities (even if the technocratic and corporativistic visions had a slight dominance). The national technological structure was noted for its developed academic and industrial capacities, as for their interactive relationship and the support of state authorities.

3. The technological infrastructure under state socialism and its decline

The national technological infrastructure has been mobilised by the autocratic political regime in response to the aims of primary modernisation and for the political issues of the techno-science agenda (see para 1). Since the 1970s it has been exposed to the impact of reversed modernity. In terms of funding and scale, the capacities of research, of technologies and of education were extensive and growing, but their marginal utility - in relation to new technological trends and their social implications - has been declining rapidly. The closed regulatory system's limited ability to mobilise the new relationship between technological and social resources has become evident. Indeed, both the economy's and the rigid institutional framework's lack of innovative pull divorced scientific and educational capacities from technical and productive ones and led to a *disintegration of the national technological infrastructure.* The existing industrial technologies were no longer able to ease economic tensions. On the contrary, they became the main cause for the increase in shortages in energy and materials and the depletion of the natural environment. Such technological stability (or push) constituted the reverse side of the autocratic power system, which lacked the means for political and social mobilisation. Its survival depended on a decline in the regulatory power's authority and the mobilisation of the traditionalistic potential of culture.

At the end of the 80s the technological framework could be characterised as *extended sectoralisation.* The traditional interactive potential responded to mostly informal communicative networks while the formal power of the institutions (with their vertical communication and orientation) began to prevail. The social features of such

sector-oriented development emerged rapidly after the liberalisation of the economic and political regulatory systems. They became manifest in the absence of productive border lines and mediation between the institutions (and in the impact of corruptive pressures upon their specific function) as well as in the social resistance shaped by traditional patterns of competencies and responsibilities. No links between science, technology and production are visible; science is claimed (by scientists) to be a part of culture but both seem to be irrelevant to economic and public actors. The perspectives of production, education and state regulatory practices are assessed independent of national S&T structures. However, the liberalisation of the economic political system and the strategy of radical economic reform, have both exposed the deficiencies of the inherited power structures as well as creating the possibility of understanding them and improving the political choices which seek to overcome them.

4. Structural problems of transforming the technological potential of production after 1989

The sectoralisation process of the production system has been shaped by a branch-oriented regulatory system which has resisted the inter-branch networking and prevented the growth of new (post-industrial) production orientations. The industrial structure had been shaped by a tendency to close technical systems favouring a concentration of regulatory power and disregarding the external environment; hence the complexes of „heavy" industries with heavy or bulk production grew (coal-metallurgy-machinery, raw materials-building construction, agriculture-food processing, crude oil-petrochemistry). The possibility of sustaining technical growth within relatively stable production structures, with easily available sources of funds (including military orders), with low possibilities of utilising specialisation and with a low pull of users resulted in a peculiar system of production logistics: namely the establishment of closed production units with a massive internal consumption of „home-made" products (engineering consumed a full 60 per cent of its output for its own needs, the corresponding figure for the electronics industry being 50 per cent). The economic transformation is facing considerable problems in the re-structuration of these extensive and „closed" techno-industrial sectors.

A three-year period is naturally too short to offer a reliable picture of the fundamental economic changes that are expected to mobilise technological development in the emerging competitive market economy conditions. Radical de-construction of the centralistic regulatory system, coupled with a restrictive fiscal policy and the collapse of the East European markets have, to a great extent, blocked the existing growth resources of industries, forcing them to seek alternative avenues for development. Such a situation highlights, among other aspects, the available competitive potential of technological capacities as well as the true nature and factors of their restructuring. In order to assesses the technological changes in production, several analytical perspectives have been adopted: the shifts in the industrial branch structure, changes in the innovative behaviour of enterprises and the structure of technology transfer.

Within the changing economic rules (and the declining industrial output) the economic performance of the individual *industries* can be assessed as follows: the branches of power generation and the chemical and paper-making industries have displayed relatively good economic results, followed by the food-processing, metallurgical and glass and ceramics industries, with the biggest slump recorded in engineering and electrical engineering (a change partly attributable to a major slump in

military production).[4] As far as export is concerned, the key technological driving forces behind its reorientation to the markets of the developed countries primarily include traditional Czech manufacturing (consumption-oriented) industries whose share in the total export has risen from 32.1 to 48.5 per cent. The share of what are traditionally technology-based industrial branches (machinery, transport vehicles, chemistry) has dropped from 52 to 32 per cent. Over the same period, branches of the primary sector - fuels, raw materials and food products - have raised their exports from 15.9 to 19.4 per cent. In the import structure, the share of technology-based (engineering and chemical) industries has fallen from 46.3 to 43 per cent, while the share of other products, raw materials and semi-finished products has risen from 53.7 to 57 per cent [Kolanda 1993].

A microeconomic view of industrial branches also tends to display a considerable degree of dispersal in performance indicators, disclosing different reactions by individual industrial plants to the changing economic climate. A specific framework for evaluating this situation is offered by representative surveys of *innovation* activities [*Šetření* 1991, 1992]. Their results indicate that the impact of domestic R-D, state authorities and of credits on the innovations is decreasing, while the influence of sales pressures, competition and foreign knowledge and technology transfer is growing; the role of larger enterprises remains a significant factor in innovation activity, while the newly-established joint stock companies have manifested weak innovation activity so far.

An analysis of the *international flows of capital and technology* produces controversial pictures. From the perspective of Czech technological actors (assessed with the aid of patent statistics and the balance of technological payments) three activity patterns may be distinguished: (a) a growing interest on the part of the Czech research community in selling research-findings abroad (here the active role of researchers from the Academy of Science institutes and from industrial chemical research can be observed); (b) the active international exchange of technological findings (the leader in this group being engineering, with a 34 per cent share in payments and a 56 per cent share in the national balance of technological payments income), especially in the manufacture of machinery for heavy engineering and chemical industry; (c) the active import of technological findings (primarily the pharmaceutical industry and the crude oil processing industry).

From the perspective of foreign technological actors the capital (and technology) transfer is being directed primarily to technologically less demanding branches (the tobacco industry, glass-making, the production of non-alcoholic drinks, car-manufacturing and the production of transport technology, the food industry, banking and the chemical industry). Furthermore, the changes in the structure of patents granted to foreign applicants attest to a declining interest in technology-based domestic production (except for chemistry). They have retained an interest in the property protection of technology in the fields of medical care, transportation, storage and packaging.

The above-mentioned *divergence in the structure of the technological expectations* of domestic and foreign producers demonstrates their different economic position as

[4]) In 1987, military production accounted for a mere 3.2 per cent of the overall Czechoslovak industrial output and for some 8 per cent of its exports; arms manufacture was, however, concentrated in the spheres of general engineering (70 per cent) and the electrical engineering and electronics industries (12 per cent); in 1992, its volume registered an 80 per cent decline as compared with 1987. See [Bohatá 1992].

stemming from the persisting technology gap between the CR and Western Europe as well as from their competitive relationship, particularly in the production areas of medium level technologies. These are evident in the diverging management expectations of privatised domestic enterprises and potential foreign partners: the domestic management involved expects an easy (and cheap) inflow of sophisticated technology as well as access to the foreign partner's distribution network. It evaluates foreign co-operation as a means of improving production quality, reliability and organisation, and expects the growth of foreign investments - thus it bases its expectations on long-term targets. Foreign partners, on the other hand, are primarily interested in the immediate use of the available capacities of Czech enterprises (making use of both lower costs and sub-deliveries) and are reluctant to voice their opinion on long-term targets: they want to sell technology and know-how on market terms, to evade co-operation which poses the risk of competition and the loss of both markets and company image.

From the afore-mentioned analysis it is obvious that technologically less demanding branches (such as power generation and fuels, metallurgy, food-processing, paper-making and cellulose manufacture) have succeeded in adjusting themselves better to the new conditions than technologically more demanding branches (engineering, electrical engineering, electronics and communications technology), which are now in the grips of a profound crisis. Branches of the chemical industry, and especially those in the petrochemical sector, have managed to sustain a certain dynamism. The applied re-allocation mechanism has been working more towards mobilising available technological capacities than their restructuring in favour of smaller industrial units and of advanced technologies. So far there are no visible actors, frameworks or cognitive perspectives for such a long-term oriented change to the industrial system.

5. Structural problems of the national R and D system in the environment of economic and social transformation

Historically, the national research system followed the German pattern of institutionalisation [Ben-David 1971]: the diverse and interactive patterns of academic and industrial science were balanced by the role of the state in the promotion of public science. Since the 1950s its development witnessed - along with its isolation from Western contacts, massive reorganisation and politisation - an unprecedented upsurge in research capacities and an unparalleled concentration of research potentials in the Academies of Sciences research institutes and in the mission-oriented applied research institutes. At the same time the traditional research institutes of universities and the in-house (intramural) research units of large-scale enterprises were drained. Thus, prominent research capacities were externalised from their traditional functions in the education and production framework and exposed to centralistic and autocratic regulatory manners. In the ensuing development of the national research system this unsatisfactory distribution of research capacities was gradually corrected. The in-house research units of industrial research had been expanding since the 1960s (due to obligatory R and D enterprise funding) while university research was also in gradual recovery (in particular in agricultural and medical science and in the theoretical branches of natural science).

Both the division of academic and industrial research institutions into parallel structures and the inter-institutional barriers could, to a certain extent, have been overcome given substantial central funding. Since the beginning of the 1970s the decline in central R&D funding and the rise of enterprise R&D resources resulted in an increase

in local and institutional research aims and a decline in inter-institutional projects. The national system disintegrated into several social systems with specific cognitive and self-control functions, while the integrative (horizontal) relations became formal and ineffective. The sectoralisation of the national research system brought about a general decline in the level of research activity. According to the ISI database the overall share of Czechoslovakia's scientific output in the world-wide volume of published papers and articles dropped from 1.01 per cent (1973) to 0.88 per cent (1977) and to 0.58 per cent (1985) in the mid-1980s. In the second half of the 1980s this slump continued. In addition, the citation index of Czechoslovak articles during the latter half of the 1980s declined by a further 6.4 per cent (7,900 articles) covering 31 per cent of the overall Czechoslovak publication output registered by ISI. The citation index of Czechoslovak articles amounts to less than a half of the average citation index in the entire data base [Welljams-Dorf 1992]. Of course, the activities of research institutions in favour of research growth were not completely suppressed by domestic economic stagnation and social malaise: the international options were increasing for academic staff; the industrial research staff were able to secure funds through multiple contract research. But the power of research *vis-à-vis* the declining technological capacities and the growing social pressures, environmental among others, was decreasing dramatically.

At the end of the 1980s the institutional structure of the national research system was - in terms of funding and performance - characterised by an increasing strength in intramural (in-house) industrial research, while extramural industrial research and governmental research sectors were stagnating, even if the institutions of the Academy of Sciences were able to raise additional funds from extramural (and foreign) sources (see Table 1).

Table 1. Selected indicators of R and D sectors (CSFR, 1990, thousands, %)

indicator/sector	Ac.Sc.	HE	Govern.	Ind.Ext	Ind.Int
R and D manpower	18,1	7,4*	28,7	43,1	61,5
ibid in %	11.4	4.6	18.1	27.2	38.7
R and D expenditure in %	9.5	3.1	9.6	77.8	
share in patent ac. in %[1]	19.0	3.0	17.8		50.3
share in patent ac. in %[2]	22.9	4.2	14.2		51.4

Source: Statistická ročenka VTR 1990 (Statistical Yearbook of S and T), Praha 1991.
The Role of EC Investment in Promoting R and D Capabilities and Technological Innovation in EEC, Munich 1991.

Remarks: *) estimate of FTE of research and teaching staff at HE
[1]) technical fields, the share in total number of granted patents abroad
[2]) industrial fields, the share in total number of granted patents abroad

5.1. Changes in the size and structure of the Czech republic's R and D system during the economic reform programme (1990-1992)

The years 1990 to 1992 saw a marked drop in the sources of R and D funding: state non-investment funds (in current prices) decreased by 65 per cent to 2.6 billion Czechoslovak

crowns and enterprise funds by 26 per cent to 9.6 billion crowns. The drop in funding corresponds to the drop in the number of R and D personnel. Their total number decreased by 44 per cent (down to 60.3 thousand), of which university-trained personnel decreased by 37 per cent (down to 20 thousand). Industrial research institutes were transformed into joint-stock companies, with many of them being included into the voucher privatisation process. The implications of the reduced funding, the responses to it as well as the institutional changes differ according to the research sectors.

In comparison with other sectors, the *extramural sector of industrial research* is undergoing the biggest cutbacks. As compared with 1990, the workforce had been reduced by a full 58 per cent in 1992 (see Table 2). The cuts are, however, fairly uneven, depending on the extent and structure of activities followed by the individual research institutes. Many centres tend to scale down their research by as much as 90 per cent, attempting to cope with their problems by switching over to other activities - consultancy, certification, development, servicing or production. There is an extensive mobility in R&D staff: some teams or researchers - mostly younger and more competent ones - attempt to commercialise their skills as private entrepreneurs (within or outside the institute's framework), with about one third of staff having left the profession in order to pursue other activities.

Despite the drain in qualified personnel and decreasing funding and orders, research organisations have continued to predict that a sufficiently vast market of research findings will be created, thus enabling them to prosper as independent profit-making organisations. They expect to be able to provide technological services (mainly in the form of new approaches and methods) to various manufacturing sectors, set up and develop innovation centres and science parks and are prepared, eventually, to enter a co-operative network of industrial research institutes (to a smaller extent as a competitive situation prevails). All research organisations in this category have been included in the privatisation process, mostly in voucher form, with investment funds becoming their ultimate owners, the latter being focused, however, on short-term profit-oriented aims and do not share the above-mentioned expectations of the researchers.

The intramural sector of industrial research is also undergoing considerable restrictions (see Table 2). These reductions are dependent on the prevailing situation in the enterprise involved. In many cases such R and D capacities are transferred into production, in some cases they are simply abolished, some enterprise-based research institutions are trying to privatise themselves, some companies (usually with foreign capital) count with local R&D capacities. In view of the ongoing enterprise privatisation, especially large engineering plants where a major portion of this sector is based, their prospects remain uncertain. The influence of domestic and foreign technological and capital factors is largely contingent. However, their impact gives rise to a selective environment that is likely to affect the re-shaping of the capacities of industrial research to the standards of business enterprise sector (BES). In this context, the prospects for the continued development of the chemical industry's research base seem good; in addition, the machinery industries have preserved their research capacities, while the other industries have mostly abolished their research facilities.

In the *mission-oriented state research* sector the cutbacks in funding and the workforce have not been so radical (see Table 2). Its main actors (especially the Ministry of Health, the Ministry of Agriculture, the Ministry of the Environment and the Defence Ministry) have succeeded, even with reduced funding, in preserving a network of

research centres. In terms of the workforce, the drop amounted to 27 per cent over the three years under review. At the beginning of 1993 this sector employed 14.5 thousand people, of whom 35 per cent worked at the Ministry of Agriculture, 22.1 per cent at the Ministry of Health, and 20 per cent at the Ministry of the Environment. The individual ministries have made efforts to devise selective instruments for organising research and its funding. The selective measures adopted in the mission-oriented research capacities imply the possibility of transferring the research centres from the state sector to the private sphere and to transform those remaining into the public-related, governmental R and D sector.

During the period under scrutiny, the *sector of research institutes affiliated to the Academy of Sciences* of the Czech Republic saw its gross spending decrease by 8 per cent and its overall workforce by 29 per cent (down to 8,500) of which university-trained personnel dropped by 24 per cent (down to 4,000). In 1993 the budgetary cuts continued, with about 20 institutes being closed. Substantial changes were achieved with the restoration of the academic principles in the (self-) organisation of institutes and of the institution as a whole. An increasing proportion of funding is being distributed by means of an internal grant agency. Increased autonomy for the institutes and the utilisation of their international contacts has enabled them to reorganise their structure according to the criteria of scientific merit. New forms of interaction with HE and of knowledge transfer (science parks) are being examined. These are first signs of the transformation of the Academy of Science research institutes into the extramural sector of (strategic) research.

The *university research sector* is also experiencing hard times, with major restrictions caused by shortages in overall research funding. The maintenance of the links between research and education, ties which have been eroded in the past, is now the responsibility of individual faculties and universities which receive block grants according to the number of students. Research funding is, however, constrained by the pressure of spending cuts, as money is desperately needed for elementary outlays. Funding through contract research with domestic partners has also experienced cutbacks. A certain positive role is played by foreign funding (especially TEMPUS) and by the entry of universities into international research networks. Although universities reckon with the resumption of postgraduate studies, as yet there are no clear-cut ideas as to the possibilities and importance either of restoring the relationship between education and research or of the effective training of new research manpower within the HE system. Ways of shaping and promoting a university research sector (as it is known in western practices) have not yet fully evolved. These will probably depend on the prevailing conditions at the individual universities and on their capacity to establish links with the other research sectors.

Sweeping changes have also occurred in the realm of *research policy*, in the structure of competencies between research institutions (sectors) and the executive, legislative and political branches. The previous regulative forms have been dismantled (governmental competencies of the Academy of Sciences and the Ministry of Technology) and new forms are being sought. The changes have mostly occurred within the „sectors" and concern the legislative, organisational and funding issues; the funding procedures exploit the competitive forms (grant system, project funding) in the growing scale. The role of government in the co-ordination of research is focused upon (a) the distribution of the decreasing state R and D funds to the institutional support of the state-owned research institutions (mostly via ministries) as well as to the grant agencies, and

(b) the privatisation of state-owned research institutes. No other co-ordinative activity on the part of the Government in the selective promotion of research fields according to economic and social priorities is expected. It is argued that such selective pressures will only be formed by the new actors which grow out of the de-etatisation and the privatisation process and, furthermore, until such an environment is a reality, no explicit research policy (of government) can be productive.

Table 2. The distribution of R and D manpower by research sectors (CR, in thousands, %)

indicator/sector	extram. ind. R+D	intramur. ind. R+D	govern. R+D	AS	Univ. R+D[a]
total R+D manpower	11.8	23.7	14.5	8.5	5.5
decline (1992/1990, %)	-58	-43	-27	-29	-36
share in total (%)	18.4	37.1	22.6	13.3	8.6

[a]) FTE (estimate)

Source: Czech Statistical Office, internal sources of institutions, surveys of research sectors.

6. Structural problems facing the development of the Czech republic's education system

Before World War II the evolutionary and differentiated educational system, as was formed in the Czech lands by the industrial challenges, could attain balanced proportions of teaching (training) and educational missions, and adapt the supply of educational capabilities to public demand. Such educational traditions enabled the continuing growth of primary education, while also attaining the demand for education by selective capacities of secondary and higher grade education (HE) to be absorbed, hence keeping the level and output of the education system under control. The selective capacity was initially maintained by the close relationship between university education and university research, by productive links between secondary education and HE and, finally, by public (and economic), regulatory support of educational establishments. The differentiated education system was strong enough to capitalise on national cultural power (and to transform the cultural patterns - under the impact of the national elites - into formative educational power), even if it assumed the bureaucratic regulatory practices of the Austro-Hungarian Empire.

During the socialist reconstruction, far-reaching changes were effected in Czechoslovakia's education system. The education system, with its state support, was able to satisfy the growing interest in education which, generally speaking, emerged in the post- war era. However, the etatistic and ideological nature of the education system prevented its coping with the extending practical role of education; it was unable to balance its training and educational roles, its supply and demand dimensions, its formative and normative aims. Accordingly the education system became not only bureaucratic and disintegrated in social and functional terms, but diffused in its formation of the identity of the educational estate. The professional skills and identities were reproduced without a productive cultural framework. The educational institutions lost their cultural power while the cultural patterns were reproduced without learning instances and capabilities.

In the 1980s, the contradictions in the growth of the education system became manifest in its stagnation - both in size and performance - and in its social disintegration (sectoralisation). In particular the *sector of higher education* was ill-affected by these structural changes. The external factors - the underutilisation of HE qualifications - played a crucial role. About one half of college graduates were unable to find a job corresponding to their field of study, with the ensuing mobility transfers signalling, more or less, a decrease in acquired specialisation [Čermáková, Čermák, Kuchař 1993]. Furthermore, the initial shifts in the employment of HE manpower from the industrial branches to the non-industrial ones could not be met with a productive educational response. Since the 80s, the growth of HE has been marked by saturation trends producing university-trained graduates at a level of 100 to 120 per 10,000 inhabitants - approximately half of the amount in advanced countries. The share of university admission in the 18 to 19 age group was kept at a level of 15 to 16 per cent. This represents half the level of the advanced countries. The absence of a communicative network between HE and secondary schools undermined the rational evaluative criteria in the education system as well as the rational ground of the educational expectations of the population. Hence the growth of secondary education and apprenticeship training (see Table 3) was open to the influence of local interests and political aims.

The transformation of the HE system has been influenced by several contradictory trends. On the one hand, the legislative steps re-established the faculties' traditional academic autonomy and operational freedom, including the transformation of the regional faculties into independent universities. On the other hand, public pressure on HE, manifest in the dramatically increased demand for HE in new patterns, cannot be met with responsive action on the part of HE. On average, 50% of HE applicants (significantly more in the social sciences) cannot enter their preferred field of study. The applied regulatory framework does not offer an effective framework for HE establishments to cope with the demand and its new structural patterns. The HE system's resistance to change and its weak regulatory practices indicate a limited social space for promoting the substantial cultural shift within the education system.

Table 3. Distribution of Employment by Level of Education (CR, in %)

	1983	1989
basic education	30.4	25.1
apprenticeship training	37.8	39.9
secondary education without matriculation	4.6	3.3
secondary education completed by matriculation	20.3	23.2
higher education	6.9	8.2

Source: Centre of HE Studies, Prague 1990.

The recent developments in the *secondary education* sector also reflect the local reaction of the education establishments to the changing environment. Apprenticeship training centres have lost their previous state support and enterprise funding, and are seeking either to raise their training status or to be active in technical services. Some secondary vocational schools have been granted the competence of bachelor's training, absorbing some aspects of HE demand and, capable of being more responsive to the educational demand, have begun to compete with the established HE institutes. Secondary education

is also experiencing a considerable growth in private schools. These changes are undermining rigid sectoral structures, allowing for the re-establishment of the productive interfaces both within the education system and its social environment.

The *basic education sector* has also been granted increased autonomy but can hardly capitalise on this due to funding shortages and because structural social patterns - the low social status of schools and their teaching staff, the decreasing interest of men in this profession and the stringent administrative control and bureaucratic organisation - have shaped basic education thus far. As to basic education, the reproductive power of the autocratic power system's cultural patterns has formed the strongest roots (in both the formal and the informal way) while resistance to its bureaucratic practices has been relatively weak. Hence, its transformation faces serious internal deficiencies with both the productive links to other education sectors as well as the lack of diversified and consolidated public influence, its agencies and patrons, proving detrimental.

7. The political agenda for the transformation of the national technological infrastructure

The above analysis indicates a set of trends common to the changes being undergone by the institutions of production, research and education: (1) the changes in the regulatory environment have brought about a substantial decrease in the scale of their capacities. In the production field, it explicitly concerns the total output (of about minus 20%), in research it is even more pronounced (of around minus 50%) with education also at minus 50% (but only in relation to the growing HE demand, which, in absolute terms, is stagnating). Some of the more excessive capacities, which were a result of the nature of autarchy regime and administrative regulation, have been eliminated. However, in some industrial branches (heavy industry), the scale still exceeds a size reasonable to available resources, while, on other hand, the size of the education system is considerably lagging behind that of developed countries; (2) together with economic and political liberalisation, the de-etatisation of the regulatory system has helped both extend the range of choices enabling people to act according to their own programs and re-establish the autonomy of institutions by means of democratic and meritocratic rationale; the criteria for internal scientific assessment have been re-established; production prospects are now assessed in terms of market considerations; in the education system the need for the authority and responsibility of teachers and of the education establishments have been accepted; (3) together with the tight monetary and anti-inflationary policy the rapidly advancing privatisation is determining the power of price regulation and shaping the framework of economic calculation; the push of de-etatisation and the pull of emerging market orientations have stimulated an extensive occupational and professional mobility within the private sphere: a significant number of experts from the examined institutions have left their occupation and begun business partly within their former profession and partly outside it; the existing S&T&E institutions are being drained of their skilled and younger manpower. The chosen approach of economic mobilisation has initiated massive *re-distributive changes in the available (human and material) capacities between the state and private sectors:* skilled manpower, in particular, is moving to and shaping new centres of power (investment funds, banking, private firms, marketing & consultancy agencies).

However, the radical and formal approach of the economic reform has also revealed the society's social disintegration, its sectoral patterns and the weakness of communicative and orientation capacities. The regained autonomy and freedom of action

has allowed the *capitalisation* of the existing local capacities and positions in the regulatory system; it is, however, also the source of both the *institutional resistance* to external pressures and the *closure* within the existing institutions and their available capacities. The competitive environment and monetary orientation - born, to certain extent, of the economic reform - could affect the orientation of individual actors to transcend the existing attitudes and institutional patterns, but also strengthen the public power of the existing (even if drained) institutions. On the one hand, the potential for change is weak given institutional uncertainty, on the other hand an institutional power based on the appropriated resources is resistant to change (offering certainty but corrupting personal initiative). Co-operative trans-sectoral activities primarily occur in accordance with the appropriated technological and informal networks, promote the perspectives of large-scale enterprises and limit the options of the reform-oriented political actors to establish a competitive environment and flexible production structures. The academic and governmental research sectors are still protected by the state budget while the privatised industrial research sector is disappearing. The continuing production networks and monopolies can transfer their issues to the newly-established market and banking institution with ease. In addition, the social milieu of communality could prevail over the push from competitive, meritocratic and liberal principles in the evaluation of activities.

The prevalence of closure and „black-boxing" features over the open and competitive approach can also be observed in the arena of public reasoning. The need for a communicative assessment of different rationalisation strategies arises in the confrontation and closure of some evaluative perspectives (e.g. the environmental ones), thus reducing the arena of political discourse and public learning.

Even if some local capacities of S&T&E have been mobilised by the economic reform (e.g. the competitive advantage of traditional technologies, the professional skills for consulting and training activities) the use of the national technological infrastructure's capacities for transformation processes is partial and low. Indeed, the employment of the existing technological structure will be marked by the need to maintain large-scale organisational units, as well as by pressure on capital resources, the implementation of Fordist management and organisation methods and by the difficult adaptation to social and environmental requirements. Within this framework, the policy will continue to be forced into the role of a sub-policy, overloaded with the social implications of these structures and pre-occupied with the redistributive task of lacking resources. The social milieu will then be more responsive either to technocratic or populist visions. Such a political, economic and social framework cannot exert productive pressure on the transformation of the technological infrastructure to the modern environment.

There is no simple response to such a situation. It is a unique historical context with institutional change perplexed by a contradictory challenge: both to re-found the basic power institutions for a competitive economic and political environment in a situation of structural dependencies, and to face the pressure of modernity (with its new technological challenges, social claims and political agenda). The reality of the radical economic reform in the Czech Republic thus far indicates that both missions are not easily reconciled. The re-foundation of market actors and institutions produces *short-term effects* through the capitalisation of available capabilities but *deconstructs the infrastructural networks* (indeed exploits cultural potential without reproducing it). A limited (principle-oriented) policy could mobilise new economic actors and resist the

corrupting pressure of inherited structures. However, it is not in a position to identify either the productive but conflicting aims or the niches of new developments, and is unable to shape more reliable rules and institutional arrangements for *growth-oriented strategy*. There is no other solution to this situation than the extension of both the political system to more participative practices and the political agenda to the long-term oriented issues of social change. Of course, there are also many risks and various options [Machonin 1993] of the extended and more active, top-down political approach: in particular a closure of political perspectives by existing imbalances in the distribution of power. However, it might be possible to form an arena for the assessment of various perspectives, within which the most acceptable one would be discovered and public issues and institutional changes given acceptable shape. Such an approach will also create a space for identifying the political agenda for the transformation of S&T&E institutions, for the assessment of their role in the socio-economic transformation and for the formation of a productive national technological infrastructure.

KAREL MÜLLER *works in the field of social studies of science and technology. He graduated in economics and his post-doctoral study focused on the problems of R&D economics. He later conducted research at the Academy of Sciences, having taken part in the interdisciplinary studies of the implications of S&T. He focused on sociology, more specifically on the empirical study of research institutions in the social context and modernity concepts. At present he is teaching at Charles University, lecturing in the field of the sociology of knowledge, innovation and modernity. He is participating in research projects on the transformation of the national research system and on the study of Academy-Industry Relationship.*

References

Beck, U. 1986. *Risikogesellschaft. Auf dem Weg in eine andere Moderne.* Frankfurt am Main: Suhrkamp.

Ben-David, J. 1971. *The Scientist's Role in Society. A Comparative Study.* Englewood Cliffs, NJ: Prentice-Hall.

Bijker, W. E., J. Law 1992. *Shaping Technology/Building Society. Studies in Sociotechnical Change.* Cambridge, MA - London: MIT Press.

Bohatá, M. 1992. *Strukturální analýza vývoje obranného průmyslu ČSSR v období 1980-1991* (Structural analysis of the development of military industries in the CSFR in the period 1980-1991). Prague: Institute of Economics AS CR.

Čermáková, M.., V. Čermák, P. Kuchař 1993. *Convergence and Divergence of Higher Education and Needs of the Labour Market in the Czech Republic.* Prague: Institute of Sociology. AS CR.

Illner, M. (ed.) 1993. *Czech Republic - Transformation after 1989 and beyond. Scenario of Change Until the Year 2005.* Prague: Institute of Sociology AS CR.

Jonas, H. 1984. *Das Prinzip der Verantwortung. Versuch einer Ethik fur technologische Zivilization.* Frankfurt am Main: Suhrkamp.

Kolanda, M. 1992. *Československý průmysl a jeho národohospodářské okolí v první etapě reformy.* (Czechoslovak Industries and their Economic Environment in the First Stage of Reform.) Praha: Prognostický ústav ČSAV.

Krohn, W., G. Kuppers 1987. *Die Selbstorganisation der Wissenschaft.* Universität Bielefeld.

Machonin, P. 1993. *General Approaches to the Problems of Post-Communist Social Transformation.* Prague: Institute of Sociology AS CR.

Munch, R. 1991. *Dialektik der Kommunikationsgesellschaft.* Frankfurt am Main: Suhrkamp.

Rip, A. 1990. „Societal Construction of Research and Technology." In *Technikpolitik angesichts der Umweltkatastrophe*, hrsg. H. Krupp. Heidelberg: Physica Verlag.

Reviews of National Science and Technology Policy: Czech and Slovak Federal Republic. 1992. Paris: OECD.

Schwarz, M. 1993. „The Technological Culture: Challenges for Technology Assessment and Policy." *Science and Public Policy* 20: 281-389.

Šetření o inovacích 1991. ČSFR. (Survey of Innovations. CSFR.) 1992. Praha: Infostat.

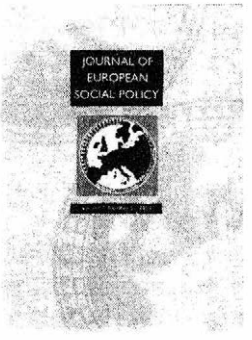
Šetření o inovacích 1991. Česká republika. (Survey of Innovations. Czech Republic.) 1992. Praha: Infostat.

Welljams-Dorof 1992. *A citationist perspective on Czechoslovak Science. 1981-1990.* Philadelphia: ISI. (presented to AS of Czech Republic).

THAT'S THE ROOT OF THE TODAY'S WORLD TRAGEDY, OLD CHAP: PEOPLE AREN'T PREPARED TO LISTEN TO EACH OTHER.

Journal of European Social Policy

Editor: Professor Graham Room,
University of Bath, UK



The dramatic changes taking place across Europe have provoked a fundamental rethinking of social policy. In addition, the moves towards economic and political integration mean that increasingly social policy decisions will be taken at a European rather than a national level.

The **Journal of European Social Policy** provides a focussed, European coverage of these issues. It features:

"Extremely impressive ... the journal can be thoroughly recommended."
European Access

* Articles providing expert analysis of key social policy issues
* Comprehensive coverage of the full range of social policy concerns
* Up-to-date reports of the latest European trends, new legislation, analysis of new and existing European Commission programmes, and recent research

The **Journal of European Social Policy** is essential reading for academic social policy analysts and policy-makers at European, national and local levels.

Volume 4, 1994	UK	W Eur	E Eur	RoW
Institutional	£74	£76	£44	£81/$141
Individual	£37	£39	£23	£41/ $71
ISSN 0958-9287	(4 issues per year)			

LONGMAN
HIGHER
EDUCATION

For a FREE sample issue of the *Journal of European Social Policy*, with no obligation to subscribe, return this coupon to:

Judy Higgins, Longman Higher Education, Longman House, Burnt Mill, Harlow, Essex CM20 2JE, UK.
Fax (0279) 623862.

Name _____

Address _____

_____

_____

_____