Technological and Organisational Change: A Challenge to Eastern Europe

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Widening Technological Gap

The profound technological and social changes unfolding in industrially advanced countries (IACs) and in some newly industrialising countries (NICs), discussed in detail elsewhere in this *Bulletin*, are a major challenge to Eastern Europe.[1] The technological gap between East and West (and even between East and some NICs) has been widening since the early 1970s. Falling market shares in OECD manufactures imports indicate this tendency clearly (see Table 1), and contrast with the significant increase in the share of the LDCs.

These gains by LDCs were larger than the losses of the East, and it is therefore not convincing to argue that Eastern Europe was simply 'crowded out' from OECD markets by low wage exporters from the South.

Table 1 reveals that in the majority of the more technology intensive subdivisions of manufactures the share of Eastern Europe fell to negligible levels. In our view, the poor trade performance of Eastern Europe reflects more the widening of the technological gap and the intensification of system-specific domestic problems [see Kornai 1980, 1986; Gomulka 1986] than relatively high labour costs compared to LDCs, protection or dispreference.

Except for the GDR, the growth rates in the East were much lower than those in the West and the NICs. The flattening, and often negative growth rates were accompanied by a secular decline in productivity growth, acute shortages and stockpiling of useless inventories, accelerating inflation in some countries, and external indebtedness ($130 bn in 1988). They mark the crisis of a model of accumulation built on centrally allocated resources and physical planning targets (including half-hearted attempts to reform this structure).

The Key Elements of Industrial Restructuring

With only a few exceptions, short-term adjustment or emergency policies pursued by Eastern European countries have so far failed to respond adequately to underlying institutional problems and the industrial restructuring unfolding in the IACs. According to our understanding, the following key elements of contemporary industrial restructuring need special consideration in Eastern Europe:

— The rapid development and diffusion of microelectronics and information technologies that accelerate flexible automation and increase the flexibility of production in general.

— The profound changes in organisation and the capitalist labour process. 'Total quality control', 'zero defect policy', frequent changes in demand and product mix and the consequent multi-tasking of labour force require broad skills, higher levels of commitment and new forms of participation. Greater control over production results in greater involvement, and facilitates continuous incremental innovations in product and process.

— Changes in technology and work process reshape intra- and inter-firm organisational patterns. 'Just-in-time' methods rearrange shop floor and subcontracting relations. Increasingly, economies of scale give way to 'economies of cooperation'; vertical integration to horizontal. The consequent revival of small enterprises provided a boost to innovation.

— Continuous two-way interaction with the market makes demand more important. Automated retailing and distribution companies dominate manufactures in a number of branches (food, furniture, clothing, shoes, etc.). Innovation is increasingly market-led and continuous with new products and designs [Kaplinsky 1984, 1987; Hoffman and Kaplinsky 1988; Freeman 1987, 1988; Piore and Sabel 1984; Edquist and Jacobsson 1988; Cyprus Industrial Strategy 1987).

Not all of these developments have been absent from Eastern Europe. Most of them, however, manifest themselves as external advances, to be replicated. Except for microelectronics and flexible automation, adaptation in other areas progresses very slowly, if at all.

[1] Bulgaria, Czechoslovakia, German Democratic Republic, Hungary, Poland, Rumania, and the USSR.

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Table 1

Market Share of the European CMEA Countries and the Developing Countries in the OECD Total Imports of Major Manufactured Goods, 1965, 1973, 1980, 1986 (in per cent)

	European CMEA Countries				*Developing Countries*			
	1965	1973	1980	1986	1965	1973	1980	1986
Manufactures Total (SITC 5 + 6 + 7 + 8)	1.9	2.0	1.9	1.3	7.6	8.0	11.5	14.1
Chemicals (SITC 5)	2.3	2.0	2.9	2.2	5.6	4.4	5.3	5.5
Manufactures classified chiefly by materials (SITC 6)	2.9	3.0	2.4	2.2	14.3	13.7	15.1	16.7
Machinery and transport equipment (SITC 7)	0.8	1.0	1.0	0.5	0.7	3.2	5.6	8.7
Miscellaneous manufactures (SITC 8)	1.9	2.4	2.2	1.5	8.7	16.6	24.0	29.8
Power generating machinery (SITC 71)	0.5	1.0	1.5	0.9	1.1	2.4	4.9	9.1
Specialised machinery (SITC 72)	0.8	1.5	1.2	1.0	0.2	0.5	1.2	2.2
Metal working machinery (SITC 73)	3.5	4.3	3.8	1.7	0.1	0.5	3.0	7.5
General industrial machinery and equipment (SITC 74)	0.4	0.7	0.8	0.7	0.3	0.6	2.0	5.0
Office machines and automatic data processing equipment (SITC 75)	0.8	0.2	0.2	0.0	0.5	4.3	4.5	12.0
Telecommunications and sound recording and reproducing apparatus and equipment (SITC 76)	0.5	0.4	0.3	0.2	2.4	14.1	22.5	22.8
Professional, scientific and controlling instruments (SITC 87)	0.9	0.7	0.5	0.3	0.8	1.7	3.6	5.3
Photo apparatus, optical goods and watches (SITC 88)	1.0	0.7	0.5	0.3	1.0	3.1	12.7	13.0

Note: European CMEA countries: Bulgaria, Czechoslovakia, GDR, Hungary, Poland, Romania and the USSR; Developing Countries: total non-OECD countries — European non-OECD countries.

Source: Calculated from *Trade by Commodities*, Series C, Imports 1981, Paris, 1983; OECD and *Annual Foreign Trade Statistics by Commodities*, Series C, Imports, 1986, Paris, 1988.

Flexible Automation in Eastern Europe

The two most important innovations paving the way for automation and flexible manufacturing were the digital computer in the 1950s and the integrated circuit and microcomputer in the early 1970s. In both areas Eastern European countries followed developments in IACs with a substantial delay. But, in the case of flexible manufacturing systems (FMS), the gap appears, at this early stage in their diffusion, to be much smaller.

The first FMS was built by Kearney & Trecker in the USA in 1970. In the same year the GDR (the third largest exporter of machine tools in the world behind Japan and West Germany) started its programme with PRISMA (prismatic) and ROTA (rotational) FMS. STANKI-72, a Soviet FMS was introduced in 1972. In the 1970s practically all Eastern European countries embarked on developing and installing FMS. According to one US estimate in 1980, out of the 125 FMS implemented worldwide, 25 were deployed in Eastern Europe [UN ECE 1986:27]. The USSR was second only to Japan in the number of installed systems.

A number of designers and manufacturers are engaged in developing, producing and installing FMS in the USSR. In 1985, when there were about 60 FMS's in operation in the USSR, plans existed to instal 1,800 FMS's by 1990 [Vasiliev 1985:101-3]. However, this very high figure seems extremely ambitious. Nevertheless the USSR is most likely to remain one of the largest producers and users of FMS. According to Soviet sources, in the middle of the 1980s half of Soviet FMS's were used by the machine tool industry itself; 25 per cent were installed in the automative, and 10 per cent in the electrical machinery industries[2] [Vasiliev 1985:101-3]. This pattern differs from that in Western Europe where the machine tool industry represented only 9 per cent, the automative industry 43 per cent, aerospace 9 per cent, and other sectors 39 per cent [UN ECE 1986:52]. The figures suggest that in the USSR FMS's were introduced primarily for rather specific uses in the machine tool and other industries, probably to improve product quality and not to increase the flexibility and productivity of mass producing consumer goods industries. This contrasts with Western Europe, where the mass producing automative industry is the single largest user. It is also considered to be one of the most important factors explaining the flexibility and cost-competitiveness of the Japanese auto and component producers, where its use is already widespread [Hoffman and Kaplinsky 1988:160-5]. The US and European industries are likely to follow soon [Hoffman and Kaplinsky 1988:271-7].

Another anomaly which may, perhaps, be explained by the pattern of utilisation, is the distribution between prismatic and rotational FMS's. In 1985 two thirds of Soviet FMS's were rotational types, whereas elsewhere the prismatic (or box-type) FMS's predominated [UN ECE 1986:45]. Automation of the production of rotational parts is regarded as more complicated technologically than that of prismatic or flat parts. The heavy bias in favour of rotational FMS's in the USSR is thus a potential advantage for Soviet FMS producers in international trade. So far, however, there is no information about exports of Soviet rotational FMS's.

The GDR, the second largest producer and user of FMS's in Eastern Europe (13 in operation in 1985), can draw on a machine tool industry with a long tradition. The country was one of the pioneers of FMS technology in the world, and regards it as a priority area both as far as domestic industry and exports are concerned. These FMS's were produced by three specialised divisions of the same *kombinat*, a special administrative-economic unit. The GDR has also developed a variety of robots and computer control devices essential to the country's FMS programme. Exports are picking up but, so far, mainly to CMEA countries. Some of the exported FMS's were large complex systems such as one delivered to a truck plant in the USSR comprising 50 machining centres and using automatically guided vehicles (AGVs) [Kochan 1986: 131-2].

There is only limited empirical information on the performance and the impact of installing FMS's in the GDR. A system called PC-3 handles prismatic parts up to 7 metres length and 20 tonnes weight. The line is 57 metres long with 14 locations including five large machining centres. It could process 120 different parts at a rate of two and a half parts per day. More than 10 PC-3 FMS's were in operation in 1985. Labour productivity has been increased by 300 to 500 per cent compared to traditional manufacture; space requirements have been reduced by a half, and lead times by two thirds [UN ECE 1986:252].

Eastern European literature makes little reference to the increased organisational problems related to the introduction of FMS. In comparison, in those companies we visited in England, organisation and human factors appeared to be equal in importance to issues related to hardware. There is also no mention of the problems of supply security, or inventory reduction. However, our experiences and the literature on shortage economics suggest that availability of inputs is of crucial importance [Kornai 1980]. This is even more so in the case of FMS since disruptions in input supply may occur more frequently because of the larger variety of parts processed and more frequent changes in product mix.

There is some controversy concerning the diffusion of FMS's in Czechoslovakia. According to the UN ECE study, there were 11 FMS's in operation in the country in 1985 [UN ECE 1986:182-3]. There are two main manufacturers of FMC's and FMS's, five producers of transportation and handling equipment for FMS and 20 to 30 firms manufacturing other components. In Hungary (nine FMS's installed by 1985), two major companies produce machining centres and FMS's. A number of institutions and other companies cooperate with these producers in projects sponsored by the Ministry of Industry and the National Committee for Technological Development. Participating companies receive financial support for R & D on a contract basis (up to 50 per cent of related costs). The domestic market, however, is not secured for Hungarian manufacturers. In fact, half of the installed FMS's were imported from West Germany and Austria. One of the FMS producers, the Csepel Machine-Tool Works manufactures the Japanese Yasda YBM 900 N under licence, but it has also built its own system called IGYR 630. The other producer, SZIM, which employs almost 5,000 workers, has been included in a list for foreign investors aiming to attract capital and

[2] The remaining 15 per cent was unidentified.

technology for the development of the industry [Réti 1989:1]. Hungarian FMS producers used mainly TPA-70 minicomputers and R10 computers built by the Hungarian VIDEOTON company in the framework of the cooperation programme with CMEA countries on computer development, production and trade, adopted in 1969.

In Bulgaria (six FMS's in 1985), there are also two FMS producers (ISO Tekhnoinvest and VTO Machinoexport). Electronic control devices and machine tools are manufactured with domestic technology; robots and manipulators are built on the basis of a licence agreement with the leading Japanese FANUC company. Between 1977-79 Poland developed three experimental FMS's (KOR-I, TOR-I and TOR-IM), but the economic and social crises of the 1980s has substantially slowed down further developments. There is no information about recent installations. Similarly, the first experimental FMS was built in 1979 in Rumania, using domestic machine tools and controlling computers [UN ECE 1986:79].

The early development of FMS and other automation techniques in Eastern Europe must thus be seen largely as an anomaly. It is explained by (1) the interest of the military sector in high precision small batch production and the higher technological standards of FMS; (2) the eligibility of FMS for centrally initiated R & D efforts; (3) the shortage of labour; (4) the long tradition of the machine tool industry; (5) scientific ambitions and (6) the demonstration effect of West German developments.

It is clear that Eastern European governments regarded flexible automation as a priority area and therefore they have devoted resources to it. Preferential treatment resulted in a rapid increase of R & D activities during the 1970s and a number of installations in the early 1980s. However, accumulating economic problems slowed this process down considerably in the 1980s.

Having surveyed the diffusion of flexible automation technologies in CMEA countries, we now consider in more detail, the related experience of two countries: Poland and Hungary.

Crisis and Innovation: The Case of Poland

Since the end of the 1970s, Poland has been severely hit by an economic and social crisis. In many aspects it is no exaggeration to talk about a lost decade. Most economic indicators fell drastically between 1978-82 and had not regained 1978 levels by the end of 1986 (see Table 2).

Most remarkable (from our point of view) has been the huge fall in capital productivity between 1978-82 (35.6 per cent) and the fact that it hardly improved through the 1980s. Large sectors of industry face

Table 2 **Some Basic Indicators of the Polish Economy 1982/1978 and 1986/1978 (%)**

	1982/1978	*1986/1978*
Net material product	76.4	92.7
Net industrial product	76.5	93.2
Labour productivity	78.8	93.7
Capital productivity in economy	64.4	69.9
Capital productivity in industry	64.4	69.9

Source: Calculated from *Polish Economy in the External Environment in the 1980s*, World Economy Research Institute, CSPS, Warsaw, 1988.

decapitalisation,[3] and the rate of capital replacement is low.[4] The servicing of Poland's huge debts (over $40 bn) has led to severe import restrictions which are often self-destructive. Technological development, a key to better export performance, has also suffered. Not a single licence was imported in 1981-82 (Table 3) and altogether only 16 licences were purchased from abroad between 1980-86. In the same period 210 licence agreements expired, so that in 1986 only 99 licence agreements remained active. Of these, 82 were used in production. The appropriateness of this policy response is questionable. By contrast, in the same period, Hungary faced similar problems, with one quarter of Poland's population, and with much higher per capita debts.[5] However, it imported thousands of licences in steadily increasing numbers.[6] Production based on some kind of foreign cooperation (licence, know-how, subcontracting, etc.) accounting for almost 14 per cent of domestic sales and 32.1 per cent of total exports in 1986.[7]

The domestic indigenous innovation base also suffered. The number of R & D personnel decreased

[3] Komunikat GUS, *Rzeczpospolita*, No. 23, January 27, 1989.

[4] Four per cent between 1982 and 1986: see *Rocznik Statystyczny GUS*, 1987, Warsaw.

[5] At the end of 1988 Hungary had a per capita debt of $1,700, while that of Poland was $1,100.

[6] Licence imports to Hungary: 1981:517; 1982:565; 1983:762; 1984:825; 1985:896; 1986:943. Data extracted from *Statistical Year Book 1986*. Hungarian Central Statistical Office, Budapest p 150 and *Statistical Pocket Book of Hungary 1987*, Budapest, 1988, p 112.

[7] If Hungary had followed the policy of ruling out licences and other forms of foreign cooperation, and had consequently not been able to substitute for falling exports it would have had a debt/export ratio almost identical to that of Poland. The argument that Hungary could and Poland could not afford licence imports is therefore not self-evident.

Table 3

Indicators Related to Technological Development in Poland

	1979	1980	1981	1982	1983	1984	1985	1986
Employment in R & D (thousands)	233.9	223.9	203.2	173.7	163.2	158.7	162.7	160.6
R & D expenditures as % of NMP	1.98	2.03	1.87	1.41	1.33	1.50	1.71	2.29
Number of patents granted	4,656	5,736	4,693	3,611	3,617	3,532	3,894	3,230
Domestic inventions patented abroad		130	71	42	59	91	71	69
Licence imports	31	7	nil	nil	2	1	3	3

Source: Statistical Yearbook GUS, 1984 and 1987, Warsaw.
NMP — Net Material Product

by almost one third between 1978 and 1986. Research expenditure fell back, both in absolute and relative terms. As a result, the number of Polish patents contracted by more than 43 per cent between 1980 and 1986. Polish inventions patented abroad fell from the very low level of 1980 to less than half in the 1980s. According to Poznanski, most of the innovations in Polish industry are small process innovations of relative insignificance [Poznanski 1980:232-53].

The lack of product innovation and the weakness of the innovation process are most tangible in two developments. First, the number of new products entering production declined from over 8,000 annually in the late 1970s to just over 4,000 in 1984. In 1988 only 1,500 new technologies and 5,300 new products were initiated. Second, Poland not only lost market shares in foreign markets as far as technology intensive branches are concerned (the share of machinery exports decreased from 44.4 to 39.4 per cent between 1982-85), in some formerly important technology intensive industries (machines for specialised industries, metalworking machinery, telecommunication equipment, motor vehicle parts, road vehicles, aircraft equipment, ships and boats) there was not only relative but absolute decline. These are precisely the industries where flexible automation is becoming a key component of international competitiveness.

The Polish case shows clearly that a policy of restrictions can only guarantee very short-term adjustment to external imbalances, and inescapably undermines technological competitiveness. As a consequence of such a policy, Poland's ability to innovate has substantially decreased, hindering both technological development and the long-term adjustment of the economy.

Slow Diffusion of Microelectronics: The Case of Hungary

Microelectronics is indisputably the heartland technology in the present radical technological change [Freeman 1984; Kaplinsky 1982 and 1987]. Its diffusion is perhaps the largest single source of productivity improvement in the 1980s. Microelectronics has developed at an astonishing and accelerating pace throughout the second half of the 1970s and the 1980s, and Eastern Europe has found it increasingly difficult to adjust to the pace of change. It has reacted slowly, rather than adopting active policies. Five-year planning horizons have proved to be too long to make and carry out major investment decisions in microelectronics, and R & D and innovation cycles have often shrunk to one or two years.

The radical changes initiated by the downstream diffusion of microelectronics were not apparent in the early 1970s when Eastern Europe had greater access to foreign resources from commercial banks. By the early 1980s Eastern Europe had plunged into economic crisis and reacted with restrictive policies, bringing cuts in investment programmes. The investment cuts triggered off a tough bargaining process in which the interests of microelectronics (seen as an industry of the future) were underrepresented, and were consequently overshadowed by the influential metal-working, energy and raw material lobbies. The vision of more flexible and less energy and material intensive production (through using microelectronics) proved to have less impact than the wide-scale power shortages which were, in some countries, leaving apartments dark and cold. As a consequence of pressure from the energy lobby, in most Eastern European countries the share of the energy sector in total industrial investments surpassed 40 per cent and kept on increasing. In Hungary it reached close to 50 per cent, leaving precious little for other industries. Failure to adjust to the oil crisis probably constitutes one of the major reasons for the further widening of the technological gap between East and West. The investment barriers to indigenous technological development in this sector, as well as to the diffusion of microelectronics have been reinforced in the 1980s by a severe hard currency shortage, import restrictions and the efficacy of the COCOM ban on high technology.

In 1983 Hungary spent US$50 per capita on microelectronics, whereas IACs spent around US$400-500 (Hoványi 1985) — and Hungary was not the worst performer in Eastern Europe. In 1984 the government increasingly realised the danger of worsening competitiveness due to the slow diffusion of microelectronics, and adopted a programme to promote it. But it was both too late and inadequate. To compound these problems, the only microchip producing plant burnt down in 1986.

On the other hand, the re-emergence of privately-owned small businesses after 1981 clustered in microcomputing. Thousands attempted to copy the Californian miracle, scattered in garages in Budapest and elsewhere in the country. Some of them succeeded.

Around 100 different Hungarian microcomputer designs were developed in this period. They were expensive, not compatible with each other (or with Western standards), lacked adequate software support and lagged behind Western developments. However, the scarcity of hard currencies, general import restrictions, and the COCOM ban provided an unintended protection to this 'infant' industry. In the meantime software houses emerged, with some international success, especially in computer games. But the inferior domestic hardware basis proved to be an important obstacle to their expansion. By 1985, when microcomputer world prices started to fall, a number of XT and AT clones had appeared and competed with each other and other models and some imported Far Eastern clones. All of them were sold at well above world market prices, and it was only state intervention in 1987 which brought prices down. Microcomputer prices dropped by 20-40 per cent in 1988 [Takács 1988:1]. Five enterprises, selected by tender, were given substantial import licences for components but, for other enterprises, import controls were tightened.

Despite the high prices, the number of microcomputers increased 30 fold between 1983 and 1987, doubling almost every year (see Table 4). However, the number of mainframe computers was low, and stagnated due to budgetary constraints. (The sudden rise in the number of mainframes in 1986 was due to changes in statistical practices.) Most enterprises were reluctant to purchase CMEA computers, and few had the resources (or COCOM approval) to import from the West.

One consequence has been that the number of local networks increased [Takács 1988:4]. This forced substitution has led companies to try to solve their problems with sub-optimal computers, which generally leads to high cost and inefficient solutions.

One 1982 study compared organisational responses to the introduction of microelectronics in the service sector in the UK, Sweden, West Germany, Belgium, Italy and Hungary. The Hungarian sample also included industrial enterprises. The results of the detailed comparison showed three major characteristic differences between the responses of Hungarian organisations and those in IACs:

Table 4 **Number of Computers in Hungary 1983-1987**

	1983	*1984*	*1985*	*1986*	*1987*
Microcomputers	3,257	8,120	16,587	36,857	62,893
Minicomputers	1,476	2,331	2,952	1,625	1,731
Midicomputers	235	250	249	297	339
Mainframe computers	6	7	8	25	20
Total	4,974	10,708	19,796	38,804	64,983

Source: Takács 1988:1.

- the organisational configuration, and the division of labour within the organisation changed more often, and more significantly, in capitalist organisations;
- the degree of sectoral centralisation often increased in the capitalist sample, while it remained at a high level in Hungarian organisations (due to originally higher levels);
- economic performance improved much more in capitalist organisations than in Hungarian ones.

[Balaton 1988:134]

Another important difference emerged when the initiation of the introduction of computers was examined. In one out of four cases the introduction of microelectronics was initiated from outside, mainly by central bodies in Hungary. By contrast, there were no such cases in the Western sample [Balaton 1988:107-8]. A detailed analysis revealed that in Hungary economic motivation, though present in almost half of the cases, very rarely played a primary role in the introduction of microelectronics. The influence of the political-institutional structure and personal ambitions together were found to be the most important motivations in introducing computers [Balaton 1988:107]. Contrary to theoretical expectations and experiences elsewhere in the Hungarian sample, there was an increase in the degree of specialisation within organisations, so that the proportion of routine activities rose as a result of the introduction of computers [Balaton 1988:84]. In these Hungarian cases microelectronics increased the flexibility of neither the organisation nor the labour process.

Conclusions

The technological gap between East and West has been widening as a consequence of current profound technological and organisational changes in IACs. Eastern European countries faced these changes mainly as externally induced challenges, and have failed so far to formulate an adequate policy response. Falling market shares in world trade and deteriorating economic performances at home are direct symptoms of this failure.

Flexible automation, especially FMS, is an area of radical technological change where Eastern Europe started development simultaneously with the West, and the evidence suggests that the technological gap did not increase in this particular field until the early 1980s. On the contrary, there were a number of special features of Eastern European FMS developments, e.g. the higher share of rotational FMS versus prismatic ones as compared to the West, that might have constituted possible advantages in international trade.

However, accumulating system-specific and external economic problems forced Eastern European governments to adopt restrictive economic policies which substantially reduced the pace of technological development. The case of Poland revealed the dramatic impact of the social and economic crisis on innovation abilities. The slow development and diffusion of microelectronics in Hungary proved to be a combined result of macroeconomic constraints, inappropriate structural policy and system-specific weak motivation. Empirical evidence suggests that the technological potential of microelectronics, accompanied by changes in organisation and the labour process to increase flexibility, could not be exploited in the absence of conducive enabling conditions. This suggests that the full social and economic benefits of microelectronics will only be realised in the broader context of organisational and institutional changes. It is extremely important to try to catch up with IACs as far as embodied technologies are concerned, but this seems to be feasible only if prior institutional and organisational changes take place. These enabling conditions must be put high on the policy agenda.