NICOS KOMNINOS

Technological Change and Metropolitan Development

Ανάτυπο από την Επιστημονική Επετηρίδα της Πολυτεχνικής Σχολής,
Τμήμα Αρχιτεκτόνων, τ. ΙΑ', 1988

ΘΕΣΣΑΛΟΝΙΚΗ 1988

Ε.Ε.Π.Σ. του Α.Π.Θ., Τμ. Αρχιτεκτ., τ. ΙΑ', 1988, σ. 13-24

Technological Change and Metropolitan Development*

NICOS KOMNINOS**

With the crisis which occured in the early 70s the question of the labour process and new technology became the focus of attention for an additional reason. To them was attributed a particular role in breaking the previous regime of accumulation and the balance between sectors of production, worker's productivity and consumption, investments and profits. The development of new technology was also linked with radical changes of the spatiality of social practices and relations. Out of these changes our description concerns the new metropolitan spatiality of production and exchange activities which emerge after the crisis of the fordist organization of work and the introduction of new technologies in the production process.

The text is divided into three sections. In the first section we will examine the relations between technical, social and spatial division of labour, considering that this articulation transfers the changes of the labour process at the spatial level. In the second section we will try to make clear how new technology is constituted today, in which industrial branches innovations are concentrated. Finally, in the third section, we will describe the metropolitan spatiality which emerges from the mobility of innovative firms, from the locational choises of R and D, and from the reorganization of the non productive activities.

---

* Paper presented at the conference on Spatial Structures and Social Process, Lesvos, August 1985.

** Faculty of Architecture, Aristotle University of Thessaloniki, Greece.

1. DIVISION OF LABOUR, TECHNOLOGY AND SPACE

Division of labour occurs in three forms: technical, social and spatial. Technical division arises at the level of production through specialization of duties of workers. It is based on production technology: the discipline and product of each worker is objectified as a command of the total productive system. On the level of production every partial task is related to every other, cooperation thus being secured, and the final product is shaped by the combination of fragmented tasks. Social division of labour has different origins: it originates in physiological differentiation of sex and age among members of a community and in the exchange of products. Particularly through exchange the different branches of production are interelated and further division is realised. Finally, the spatial division of labour originates from the geographical distribution of sections and sectors of technical and social divisions. It follows both the differenciation of production and exchange relations (Marx 1978, Mignione 1982, Massey 1979, Soja 1980).

In the evolution of the capitalist division of labour four major periods can be distinguished: cooperation, manufacture, mechanization and automation. During each period the forms of interaction among technical, social and spatial division of labour are different.

Cooperation is the concentration of technicians deprived of the means of production under the authority of capital. Althougth workers loose the maitrise of the total production process they maintain the control over their individual work. The increase of productivity is due to the combination of individual capacities, to the decrease of variances of individual product, to competition which is developed among workers. Considerable economies also occur in materials of production, in tools, buildings and other infrastructures. We must note that cooperation does not originate from the free union of technicians, but, on the contragy, it follows the separation of capital and labour. As the possessor of capital is not able to assure, by himself, organisation, management and control of production, he transfers a part of these responsibilities to a category of workers and so new social strata are formed. At the same time in order to increase productivity he relates salary to efficiency, he enhances competition and finally he specialises the individual tasks.

With the specialisation of the labour force a new form of capitalist organization of work is established: manufacture. It is a two way organization of labour. Either the total process is divided into sub-units and production is based on the mechanical assembling of parts which are produced independantly, or the total productive process is organised as a time serie of connected, step by step tasks. Manufactural technical organization develops the hierarchical segregation of the workers and the simplification of individual tasks. A collective production system becomes established concentrating the intelligence of the production process. To this are transfered the skills and the complexities, lost by the individual labourer.

In these initial periods of evolution of capitalist organization of labour, technical division is limited to the factory field and does not assume any further georgaphical dimension. The spatial division of labour follows the movements of sectors and branches of production and depends exclusively upon the social division of labour. Its typical forms are city's and country's spatialities corresponding to sectoral separation of industry and agriculture and the branch-industrial specialisation of certain territories.

Further progress in the manufactural difision of labour comes after the introduction of machines to production. In this stage, the workers are linked with the system of machines and they are intensified to the limits of their capacities through «Scientific Organization of Work». Important stages of the mechanization are the taylorist and fordist organizations of work. Taylorism was born in the U.S.A during the 1870's and intoduced a vertical and a horizontal division of tasks. Vertically, conception, design and execution are separated. The «savoir faire» of the professional workers is transfered to the design offices while their work is determined through time and motion study. Horizontally, tasks are distinguished according to the analysis of elementary handlings, and each of them is given to one and only one worker. The new type of collective worker, so formed, appears very productive. The combination of the taylorist divisions with the assembly line characterises the fordist organization. H. Ford transfered, in automobile production, the principles which were being applied in Chicago slaughter houses, and he can be considered to have continued Taylor's work, since he mechanised the fragmented tasks of the previous organization. This time it is the machine which dictates the rythm of work.

During the period of mechanization and especially after fordism, the technical division of labour was removed from the factory field and assumed clear spatial expression. In the beginning we observe the spatial separation of production and administration. Then the assembly line is divided into semi-automatic parts and the total production process can de also split up into many locations. The spatial division of labour begins to combine the geographical structure with the technical and social ones.

In the early 1970's, besides the assembly line, the already classical image of mechanization, appear robots and automatised systems of production. Automation began from the section producing intermediate means of production, but soon, with the crisis of 1973-1974, it was extended to all production sections (I and II). The changes introduced by automation concern the homogeneity and the further specialisation of work. All fabrication work is subject to a process of homogeneity arount the basic unit of work which is the multifunctional workshop. Multifunctionality is based on the independance of tools and products and concerns both the means of production and the labour force; the former can be used in different productions and the latter is specialised in more than one task-place of work (Ioakeimoglou 1983). But in an other part of production, in the conception of programs for computers and au-

tomated machines, labour becomes more complicated and specialised.

Automation, information technology and new technology-related activities reverse the previous forms of spatial divisions of labour and the corresponding spatialities. But before we describe the structure of the emerging spatiality, especially the metropolitan, we have to delimit further some basic features of the new organization of labour and production.

2. INNOVATIONS, NEW INDUSTRIAL ACTIVITIES AND FORMS OF ORGANIZATION OF LABOUR

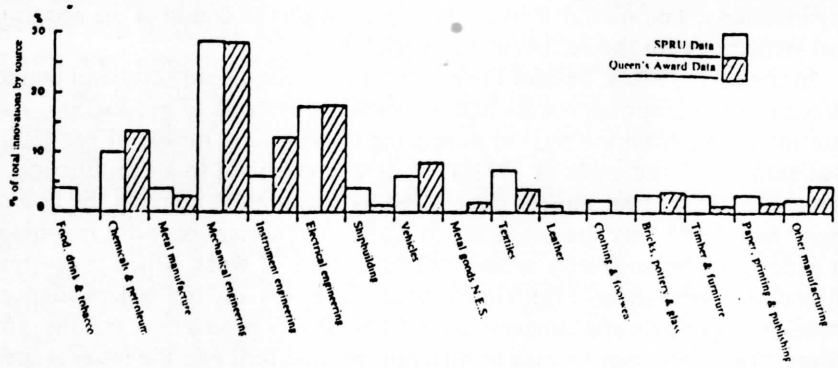
We consider that it is not possible to separate the new forms of organization of labour from innovation adn high-tech industry; the new forms of organization of production pressupose specific technological conditions which are produced and applied by certain industrial innovative branches.

Brehemy et al (1983) claim that the available litterature shows great confusion as to just what constitutes high-technology industry. Such confusion has allowed the excuse to assign the term «high tech» to all manner of firms, industries and processes. Even official reports use the term very vaguely, often referrinq generally to electronics or electronics-related activities. On the other hand existing work on defining high-tech has tented to relate it to the production and application of innovations.

Starting with a subjective definition of innovations, Oakey at al (1980) claim that high-tech branches in the U.K. - where postwar innovations are mainly concentrated (see table 1) - are those of Chemicals, Mechanical, Instrument and Electrical Engineering.

From a more recent work by Rothwell (1982) on the role of technology in industrial transformation in the U.K., it follows that five industrial branches

TABLE 1. Distridution of innovation by industrial branch in the U.K.



Source: Oakey R., R.T. Thwaites, P.A. Nash (1980)

concentrate the 72% of total innovations, considering as innovation the first industrial application of a new technique. These branches being Chemicals (271-9), Mechanical Eng. (331-23), Instrument Eng. (351-4), Electrical Eng. (361-9) and Vehicles (380-5).

R. Norton, and J. Rees (1979) in their study of manufacturing in the U.S.A., classify industrial branches in high and low technology groups according the increase in value added and the degree of technological intensity. With these set of criteria, branches of high technology are defined as those of Electronics (SIC 36), Transport Equip. (37), Sc. Instruments (38), Chemicals (28) and Plastics (30), (see table 2).

Finally, the approach of Hall and Marcusen (1982, 1983) is different. They consider as high technology branches in the U.S.A., those which exhibit a 2 per cent per annum growth rate in employment, coupled with a ratio of production workers to total employment of 20 per cent below the national average. This definition rests on two assumptions: that high technology industries create higher than the average employment opportunities and that their occupational composition is of higher than average professional and technical nature. The application of these hypothesis by Langridge (1983) in the U.K., defines as high-tech branches those of Electronic Computers (366), Radio, Radar and

TABLE 2. Growth rates and technological characteristics of manufacturing sectors, U.S.A. 1961-72

SIC		% increase of value added 1963-72	technology intensity innov. / net sales 1961-72	major U.S. innov. 1953-73
HIGH TECHNOLOGY				
Electronics	(36)	80	1,0	53
Transport	(37)	75	0,36	29
Sc. Instruments	(38)	165	2,6	29
Chemicals	(28)	84	0,99	45
Plastics	(30)	150	1,29	15
LOW TECHNOLOGY				
Foad	(20)	63	0,04	2
Textiles	(22)	91	0,33	4
Apparel	(23)	72	0,33	4
Lumber	(24)	156	0,37	2
Furniture	(25)	99	0,37	2
Paper	(26)	77	0,22	4
Printing	(27)	93	NA	0
Petroleum	(29)	56	0,09	5
Stane, Glay	(32)	79	1,83	18
Prime metals	(33)	52	0,48	17
Fab. metals	(34)	129	0,60	10
Machinery	(35)	117	1,08	44

Source: Norton A.N., J Rees (1979)

Electronic Capital Goods (367). Further analysis of the performance of manufacturing in terms of production output, capital labour ratios, capital output ratios and occupational composition ratios, includes Chemicals in the above group.

In conclusion, although there is no adequate definition of high technology activities, it is possible to relate them to the branches of Chemicals, Electronics, Vehicles, Electrical, Mechanical and Instrument Engineering. Within, innovations are activated in a much more limited area, which, according Rothwell (1982), comprises biotechnology, energy related technologies, advanced information technology, robotics and new argo-chemicals for the regeneration of marginal land. But above all innovations and their productive applications are mainly related to what J. Pastré (1984) calls «filiére eléctronique», an articulation of information technology, automations and electronics.

The major modifications of technical division of labour which follows the application of new technology are the creation of new control functions and the reversal of the task-fragmentation tendancy. Through automation, a recomposition of the labour tasks is realised and the worker participates in more than one, previously disconnected, handling. The taylorist fragmentation is thus replaced by the principle of multifunctionality. The changes of the labour process from taylorism to automation can be presented in table 3, following.

On the level of the social division of labour, changes are also important. The introduction of new technology is followed by the reduction of employ-

TABLE 3. Forms of ogranization of labour: some characteristics

	TAYLORISM	FORDISM	AUTOMATION
Objectives	* fight against the inertia of labour force	* fight ogainst the inertia of materials, continuous production	* fight against the inertia of information, principle of regulation
Means	* separation of conception and execution	* ib. id.	* ib. id.
			* recomposition of execution
	* fragmentetion of execution	* ib. id.	* fragmentation of conception
	* establishment of working norms	* incorporation of time in machines	* incorporation of Know-how in the system of machines
Applications	* tasks of production and managment	* tasks of production	* tasks of production, conception and managment
	* production in large series	* production in large series	* production in large and small series
	* industries of non-continuous process	* industries of continuous process	* industries of continuous and non-continuous process

Source: Pastré (1984)

ment in the secondary sector, although new working places are created in the branch of electronics. On the other hand an increase and transformation of the tertiary takes place. It is a transformation which concerns both the exteriorization of certain production functions, their undertaking from independent firms and the development of commercial informations and activities. As we will see these changes of technical and social division of labour create a new spatial division and alter the metropolitan spatiality.

3. New Technology and Metropolitan Spatiality

Previous research on the subject of technical change and its spatial implications comprises a large variety of approaches, around two assumptions: a. that if the rate of technological advance varies between nations, industries and enterpises, then it seems reasonable to suppose that it also varies between regions, simply because of regional variations in industrial structure and of the mix of enterprise types, b. that the new round of technological intensification produces a new spatiality based on deindustrualization and decentralisation. From all of the literature we will focus only on the restructuring of production and exchange activities within the frame of overall metropolitan transformation.

3.1. The spatial restructuring of production

Even an elementary approach to this subject shows the necessity of distinguising the spatiality of the production of new technology and innovation from the spatiality emerging from its application; although in the begining they are tightly linked (often the first application of an innovation takes place within the producing firm), they soon become separated through the extension of applications.

The research of Oakey, Thwaites and Nash (1980) on the production and geography of innovations in the U.K. suggests that the effect of industrial structure on innovation is neutral. On the other hand, the proportion of non-productive employees is positively beneficial to innovation, mainly because NP employees carry out functions necessary to the design, development and introduction of new technology within establishments. However, not all innovations have their source of specification within the establishment of first commercial application. Collaboration with other firms, goverment or private research establishments and institutes of higher education, together with licensing agreements, may all be important, especially for smaller companies. Thus regions well endowed with such institutions might have a better record of innovations.

These conclusions are related to the analysis of E.J. Malecki (1980), who also shares Vernon's theory of «product life cycle», as to the organization of R and D and the location of technological activities in the U.S.A. In Malecki's

research, the production of innovation is related to the product cycle, the growth of firms and the corporate strategies. A small *single-product* firm tends to have a simple structure centered around its founders, with little specialization of duties. New product lines allow it to enter new markets or even to create entirely new markets. The *functional form* of company organization is a natural outgrowht of the division of labour as a firm becomes more complex and specialization of management becomes necessary. Typical functional components include marketing, finance, research and engineering, and production. As a firm's strategies takes it into new and different lines of business and market areas, the functional structure is less capable of managing the diversity within the organization. The *multidivisional form* reponds to this problem by comprising a number of product - line divisions within which most management functions are decentralised to some extent. As the multidivisional structure spreads, the form of R and D takes on a parallel standardization in which long - range research is concentrated in a central laboratory and short - term, product oriented R and D takes place within each product - line division.

Empirical evidence of the location of R and D in the multidivisional industries of Instruments (SIC 38), Aerospace (SIC 372) and Electrical and Electronic products (including computers) (SIC 357 and 36), which are already defined as high-tech branches involving rapid technological change and considerable effort at new product development, shows that it follows both the headquarters location and the concentration of highly educated labour force. Its regional variation tends to be primaly associated with large urban areas, because of the combined influence of a skilled labour force, corporate communication needs and urban amenities. There seems to be an increasing relationshp between R and D activity and city-size: the largest urban areas have the greatest concentration of industrial R and D, although, on a per capita basis smaller urban areas exhibit an important attraction, usually based on university activities or local manufacturing operations.

The immediate relation of R and D activities with highly skilled labour force and large urban areas is not exclusively American. This is particularly true of countries where the urban system is dominated by one large conurbation. For some authors also the above relations limit R and D movements towards cheap labour force countries (Kellerman 1984).

While industrial research and production of innovation develops a concentrational dynamic, the extension of its application is related to decentralization tendencies and the diffusion of the productive system. Theoretical and empirical evidence exists on the spatial diffusion of production. Niles, Carlson, Gray and Hanneman (1976) claim that an industrial structure, based on information technology, follows a process from concentration to one position to dispersion, to partial dispersion and to global dispersion - diffusion. This process includes both its internal structure and its locational pattern. Empirical evidence of the above trends is given for Italy, by Antonelli (1979) and for

France, by Planque (1983).

Fothergill and Gudgin (1979), arrive at the same conclusion, via another argument; they consider that the continuous replacement of living labour by machines, resulting from the development of automation and high rates of investment, creates new requirments for spatial extensions and pushes industries to decentralise on both an inter and inframetropolitan scale. Their argument is based upon analytical empirical research of industrial enterprises in the East Midlands, U.K. On the other hand, many high - tech industries could be characterised as «foot loose», a term which describes the absence of specific locational preferences.

Thus, a two direction evolution characterises the spatiality formed by high - tech activities and new forms of organization of labour: metropolitan concentration on the level of production of innovation and dispersion on the level of its application. At the same time, the related to automation overqualification - dequalification process, analysed by M. Freyssenet (1974), takes on a clear spatial dimension among urban centers.

3.2. The spatial restructuring of services

Automation and information technology does not transform only the spatiality of production; exchange and some tertiaty activities are introduced into a transformation process. Its starting point is the proliferation of the tertiary, due to the exteriorization of production functions and the considerable growth of exchange.

Exteriorization of automation - related activities animate the discussion about the «break down of the immediate unit of work» (Thorgren 1979, Planque 1983), but also leads to a growth of the tertiary through the development of new forms of entrepreneurial activity. A similar result is produced by increase in productivity and products through new production techniques which also increase the amount of commercial transactions and the number of non-productive workers who undertake circulation and commerce.

For every individual capital but also for the global cycle of accumulation the reduction of the expanded tertiary becomes an immediate necessity. In parenthesis we note that the finance of exchange and non-productive tertiaty may be considered as an increase of constant capital, which simply reduces the availability of value-productive investments and decrease the average rate of profit. This necessity of reduction of non-productive activities may explain the introduction of automation in the tertiary, the reduction of its personel, the deskill of managers and the new geographical mobility of services and commerce. The latter becomes part of a strategy which aims at the reduction of the functioning cost of the firms.

Empirical research about the new locational behaviour of commerce and services is very limited. He may mention the studies of Damesick (1979, 1982), Daniels (1977), Catalano and Barras (1980) on office mobility in London,

Manchester and Liverpool, and the research of Phillips and Vidal (1983) about intermetropolitan changes of employment in retail, wholesale, services, communication and goverment activities in the U.S.A. From the above studies the trends of intermetropolitan decentralization are very obvious as well as the development of commerce, service and transport — communication activities in metropolitan suburbs (see table 4).

TABLE 4. Rates of change of tertiary employment in metropolitan areas, U.S.A., 1967-1977

	50 largest SMSA's			50 small and mid-sized SMSA's			Total U.S.A.
sectors	total	central city	suburbs	total	central city	suburbs	
Retail	32,9	3,0	70,0	49,7	38,0	76,7	39,0
Wholesale	14,8	-15,9	83,1	30,7	13,0	72,7	25,0
Services	65,4	34,6	134,2	79,3	63,5	99,0	59,3
Trans-Com.	9,6	-9,2	124,9	22,1	14,0	62,3	14,5
Goverment	50,1	44,5	67,3	23,8	18,3	28,6	27,2

Source: Phillips R.S., A.C.Vidal (1983)

Information collected through questionnaires on the reasons for tertiary decentralization, presented by Damesick (1982), confirms the arguments relating it to the reduction of functioning costs. Activities related to clients remain in central areas while the departments of personnel, the elaboration of transactions, the accounting and computer - related activities decentralise. Search for economy and needs for greater space are stated as main reasons for the movements, while alternative locations are evaluated in terms of rent, accesibility and personnel recruitment.

The global result of tertiary decentalization is the transformation of both Central Business Districts and suburbs. Decentralization does not affect C.B.D. importance as central economic place, although it seems to specialise it as a place for headquarters. To this process contributes also the movement of smaller firms to outer metropolitan areas and the consequent spatial differentiation by firm size. C.B.D. is going to be established as a territory of important companies, disconnected from a «centrality» defined only in terms of land use.

* * *

A global characterization of the spatial fix which new technologies and forms of organization of labour introduce is that the concentration-decentralisation process follows that of overqualification-dequalification. Overspecialised activities of high cost develop a centralised dynamic, while low specialization activities decentralise. New technology and post -fordist organization of labour seem to transform the old geographical mosaic of development -

underdevelopment into a geography of levels of specialization. Thus a new metropolitan spatiality is going to be formed based on the restructuring of the central areas and the develompent of new productive centres corridors and high - tech nucleus. The resulting structure represents the progressive deconcentration of a dominant metropolitan city into a new polycentric city - region, where important functions (finance, goverment) remain in the urban core but others (including production, specialized services, communications) may be decentralized.

REFERENCES

ANTONELLI C. (1979). Innovation as a factor shaping industrial structure: the case of small firms, *Social Sience Information,* Vol. 18.

BREHENY M., P. CHESHIRE, R. LANGRIDGE (1983). The anatomy of job creation; industrial change in Britain's M4 corridor, *Built Enviroment,* Vol 9, No 1.

BUSWELL R.J., E.W. LEWIS (1970). The geographical distribution of industrial research activity in the United Kingdom, *Regional Studies,* No 4.

CATALANO A., R. BARRAS (1980). Office development in central Manchester, *Centre for Environmental Studies: Research series no 37,* London.

DAMESICK P. (1979). Office location and planning in the Manchester conurbation, *Town Planning Review,* No 50.

DAMESICK P. (1982). The potential for and impact of office development in the inner city of London, *Progress in Planning,* Vol. 18, Part 3.

DANIELS P.W. (1977). Office location in the Brithish conurbations. Trends and strategies, *Urban Studies,* Vol. 14.

FOTHERGILL S., G. GUDGIN (1979). The regional employnent change: a sub - regional explanation, *Progress in Planning,* Vol 12.

FREEMAN C. (1974). *The Economics of Industrial Innovation,* Penguin, Harmondsworth.

FREYSSENET M. (1974). *Le Processus de Déqualification - Suqualification de la Force de Travail,* Paris, Centre de Sociologie Urbaine.

GARRISON W.L. (1980). Impact of technological systems on cities, *Built Environment,* Vol. 6, No 2.

GRISP J. (1984). Technology provides an accurate marketing tool, *Financial Times,* 24 Avril 1984.

HALL P., A. MARKUSEN (1982) *Innovation and Regional Growth, Proposals to the National Science Foundation,* Institute of Urban and Regional Development, University of California.

IOAKEIMOGLOU I. (1983).. Automation of production and collective worker, *Theseis,* No 4 (in greek).

JANCO M., D. FURGOT (1972). *Informatique et Capitalisme,* Paris, éd Maspero, Collection Economie et Capitalisme.

KOMNINOS N., (1985). Crisis and spatial restructuring; the spatiality of development and decline, *Theseis,* No 11 (in greek).

KELLERMAN A. (1984). Telecommunications and the geography of metropolitan areas, *Progress in Human Geography,* Vol. 8, No 2.

LANGRIDGE R. (1983). *Defining High - Technology Industries,* Working Paper, University of Reading, Department of Economics.

MALECKI E.J. (1980). Corporate organization of R and D and the location of technological activities, *Regional Studies,* Vol. 14.

MARX K. (1978). *The Capital,* Athens, Sichroni Epochi (in greek).

MASSEY D. (1979). In what sense a regional problem?, *Regional Studies,* Vol. 18.

NILES J.M., F.R. CARLSON, P. GRAY, G.H. HANNEMAN (1976). *The telecommunications - transportation trade off: options for tomorrow,* New York, Wiley Interscience.

NORTON R.D., J. REES (1979). The product cycle and the spatial decentralization of American manufacturing, *Regional Studies,* Vol. 14.

OAKEY R.P., A.T. THWAITES, P.A. NASH (1980). The regional distribution of innovative manufacturing establishments in Britain, *Regional Studies,* Vol. 14.

PASTRÉ O. (1984). *L' Informatisation et l' Emploi,* Paris Editions la Decouverte.

PHILLIPS S., A.C. VIDAL (1983). The growth and restructuring of metropolitan economies, *APA Journtal,* Summer 1983.

PLANQUE B. (1983). *Innovation et Développement Regional,* Paris, Ed. Economica.

ROTHWELL R. (1982). The role of technology in industrial change; implications for regional policy, *Regional Studies,* Vol. 16.

THORNGREN B. (1970). How do contact systems affect regional development?, *Environment and Planning,* No. 2.

WORKING GROUP - ECONOMIC SUMMIT MEETING (1983, 1984). *Technology, Growth and Employment,* London, Her Majesty's Stationery Office.