EADI GENERAL CONFERENCE

Oslo, Norway

27-30 June 1990

WORKSHOP ON SCIENCE AND TECHNOLOGY

New Materials and Post Fordism

Lakis Kaounides and Robin Murray

Institute of Development Studies

University of Sussex

This note is concerned with two parallel developments in contemporary capitalism, and the relationship between them. The two developments are the shift in the organisational model of industrial production from Fordism to Post Fordism, and secondly the development of new materials. In both cases the major changes have taken place since 1973, with new materials taking off in the 1980's.

The Post Fordist argument is as follows. From the early twentieth century the dominant industrial model was that of mass production. The main features of this model were the volume production of standardised goods, using special purpose machines, semi skilled labour, and a structuring of the work process according to the principles of scientific management, (the fragmentation of tasks, the division of intellectual and manual labour, and the strict hierarchical structure of authority within the enterprise - vertical links being stronger than horizontal ones). Innovation was organised around the introduction of new models, and since the new models required expensive special purpose machinery, what was critical for enterprise profitability was scale and the maintenance of full capacity.

In recent years there appears to have been a change in many of these features. The introduction of flexible machinery and the reduction of changeover times, has allowed batch size to be smaller while maintaining plant utilisation. There has thus been an increase in product variety, and a more central role for continuous new product design. Production can now respond more rapidly to movements in the market - more firms are now, as it were, producing for order and customising their products, cutting down inventories and cut price sales of unwanted goods in the process. Product lead time has also been reduced, and both product and process innovation is now seen as continuous.

On the shop floor, job descriptions have been widened, the organisation of work has been centralised to work teams, and blue collar workers now commonly take responsibility for some maintenance, repair work, and the so-called continuous improvement. For enterprises, the key points for competitivity are less to do with costs and scale, and more with quality, design, innovation,

customisation, the quality of labour, and supporting 'software' working in the firm.

This new model has been called Post Fordism. It has been the subject of vigorous controversy, both in terms of the degree of its growth, and the extent of its breaks with Fordism. Some argued that these changes are merely developments of Fordism, introducing an automated flexibility to overcome some of the barriers of the old model (notably the reduction of stocks, and the improved use of both fixed and circulating capital in the firm). But while many of the new developments have been slowly taken on board by the traditional mass producers, there are four areas where we can talk about a qualitative change in the old model:

a) customisation and the centrality of design;
b) new organisational structures both with the firm (decentralisation, reduction in vertical layers, increase of horizontal linkages) and between firms (long term cooperative relations, particularly around quality, innovation, and product design) replacing arms length, cost based contracts;
c) changes in the work process from the Taylorist emphasis on fragmented manual tasks, to the post Taylorist attempt to industrialise or harness the mental capacities and imagination of all grades of worker, as well as increasing the intensity of work through increase autonomy and the extension of tasks.
d) systemation; the planning, development and operation of production and distribution processes as coordinated systems, within which bounded organisational autonomy takes place.

The extent of these developments is varied: between countries, sectors and firms. The areas of the world (notably the US and the UK) which had most vigorously introduced Fordism, have been slower to respond to the new developments. So the changes are not universal. There is also a danger of talking in binary oppositions. Many systems are hybrids. Features of the new system can be found well back before 1970. Mass production is still central to many branches, and the drive for scale continues (not least in the EEC). Yet to all who work in and with industry, and to empirical historians of the present, it is clear that there are major changes taking place in the

organisation of production, whose significance extends well beyond the workplace.

How does the materials economy reflect and relate to the models described above? Is it useful for example, to talk about Fordist phase of materials development? Did Fordism have a particular materials regime?

In many ways we can say the extractive and processing industries epitomised Fordism. Their key sources of competitivity were access to high grade mineral resources, and economies of scale. Both underlay the development of giant companies in many of the materials and chemicals branches, and their oligopolistic control of materials sources and international markets. Their main products were 'basic commodities', the Model T's of the mineral world. The direction of their corporate strategy therefore lay in the expansion of markets, the protection of their mineral supplies, and large processing plant. Scientific developments during this period did not have an immediate impact on the materials sector. On the one hand were the great theoretical breakthroughs from X rays in 1895 to Quantum Theory in the 1920's. But actual materials developments were still largely empirically based, because of the difficulty of operationalising the theoretical breakthroughs. Thus there was a steady development of alloys, in the steel industry for example - and metallurgy as a semi theoretical science was above all about alloys. But there were practical and theoretical limits to the range of materials that could be produced, hence the supply of basic materials products in the market was "finite", limited in flexibility and variety, and constrained in its science base and theoretical understanding.

From the viewpoint of materials users, the main consideration with respect to materials was supply security and price. Commodity materials and basic alloys were openly available on the market and were not therefore a source of inter firm competitivity. Designers in the manufacturing sector took the range and quality of materials to be worked with as given. Though some materials savings could be made in the design, materials as a design, and management variant were less important for Fordism than the effective use of fixed capital and the control of labour. Materials in that sense were a

dependent variable. This is still reflected in the form of management accounts for example, where firms deal in comparative stock levels not in ways which would reduce material stocks.

Thus in the period of Fordism, the materials economy was extensive rather than intensive. The use of materials went up in proportion to output, as did the use of electricity. The producers of materials - in the face of such growing demand - extended their territorial sources, and sought to extend their own commodity markets. The large mineral companies saw themselves as specialists in particular commodities, and they carried the main responsibility for the technical development of the materials. The users were not in the materials business; they had other concerns, and thus dealt with the material suppliers at arms length. This was the period of the large mono-materials company specialising in aluminium, steel, chemicals, zinc etc.

The change in the industrial economy of materials was dependent on the breakthrough which allowed the theoretical developments of the earlier period to be operationalised. The critical factor here was the development of instruments and computers which would allow quantification to take place. Atomic energy in the 1940's was an early example, and was made possible by the development of alloys in the earlier phase. Aerospace was another area in which there were radical materials developments in the 1950's and 1960's, but it was the super computers in the later 1970's and the 1980's which allowed the revolution to take off. For they permitted the quantitative modelling of the micro structure of materials, and the tracing of the processing path of materials in real time. Scanning tunnelling microscopes allowed scientists to see the atomic structure of matter, while the new physics simultaneous extended quantum theory, to an even greater understanding of the basic structure of matter.

The result is a capacity for materials producers to manufacture new alloys and composites, to provide a customised materials service geared to users particular requirements. It is no longer a question of user industries designing their products around a given range of materials. They are now able to ask for particular materials to be developed, and the design of the product as a whole. We can speak of

designer materials. Nor is it only the design of material and products which are being integrated. There is also a tendency for materials and component production to take place side by side even an part of the same process. Materials production and manufacturing have become, in some instances, indissoluble.

As a result the nature of the materials companies and their relationship with their customers is radically changing. The companies have increasingly diversified away from their specialised commodity products (aluminium, copper, or nickel for example) and are seeing themselves as multi-materials and multi disciplinary companies supplying technological and scientific capacity to work with users on development and supply of appropriate materials. The relative R & D expenditure has markedly risen, for it is now not so much scale and base supply sources that are crucial for competitivity but this dynamic scientific and technological capacity. The shift within the vertical chain of materials production reflects this, away from primary and primary processing as key points of control, towards the higher value added processes that interface with the materials users. The change in corporate strategy of a company like Alcoa typifies this trend.

Much of the pressure for these developments has come from the users. The 'new manufacturing competition' to use Michael Best's phrase, has shifted, on the post Fordist lines, form cost to quality, customisation and design. Customisation of the final product feeds back to a requirement for the customisation of materials. Furthermore, the rise in energy costs, and the growing significance of materials as a proportion of final operating costs accentuates further demands for materials saving and performance. Precision manufacture and working at levels of high tolerance requires high quality materials. The need to cut energy costs leads to requirements of lighter, and higher strength-to-weight materials. There are demands from the electronic industry for a whole range of new materials, as there are for the interfaces between the new electronic equipment and the varied environments in which they operate.

Thus both the demands of users and the scientific capabilities of the suppliers are pushing towards a proliferation of types of material. This in turn feeds back on to the process of materials production, for if not economies of scale but hose of scope which become central. The trend is for smaller hatch sixes, plants closer to markets, and processes which allow rapid changeover times. Commodity materials will of course remain important, but it is in the new flexible materials production that the dynamic of the industry is increasingly located.

This argument suggests two things. First that the characteristics outlined in the post Fordist thesis appear to apply to the materials sector itself. Secondly, the transformation of the materials sector is a key part of the Fordist revolution more generally: materials are a key part of the manufacturing 'system' and they are now being integrated with manufacturing both in design and in some instances in manufacture. The 'modern alchemy' of the new materials allows them to be internalised within the broader dynamic of the manufacturing process, extending the range, quality and economy of the latter. If Fordism was an extensive user of energy and materials, post Fordism can be seen as an intensive one, with the dynamic centred round materials saving and customised quality. For Third World materials producers and material users, these changes require new strategies if they are not to remain the bread and butter suppliers of commodity

References

Best, Michael, 1990, **The New Competition**, Polity Press

Kaounides, Lakis, 1989, 'New advanced Materials. Implications for Industrial Policy in Developing Countries" in UNIDO, New Technologies and Global Industrialisation, Vienna, November

_____, 1990, 'The Revolution in Material Science and Engineering', paper to Commonwealth Science Council Workshop on Awareness of Rapid Advances in **Science and Technology**, New Delhi, February

Murray, Robin, 1989, 'Fordism and Post Fordism' in Stuart Hall and Martin Jacques (eds.) **New Times**, Lawrence and Wishart

Peres, Charlotta, 1986, 'Las Nuevas Tecnologias: . Una Vision de Conjunto' in C. Ominami (ed.) La Tercera Revolucion Industrie Impactos Internacionales del Actual Viraje Tecnologico, Buenos Aires

Piore, Michael and Charles Sabel, 19??, **The Second Industrial Divide**, Basic Books

Williams, Karel, John Williams and Colin Haslam, 1989, 'Why Take the Stocks Out. Britain vs Japan', International Journal of Operational and Production Management, vol 9 no 8