CHAPTER 2

Manufacturing Change in Historical Perspective

A plethora of manufacturing industries developed in many parts of the world prior to the 18th century. These industries include branches of metal and textile manufacture, food and beverage and wood processing as well as paper making, printing, glass making, candle stick making and numerous others. Traditional industries existed largely as small scale labour intensive activites by workers who typically owned their own tools. Traditional industries frequently enjoyed strong, complementary links with agriculture and were widely dispersed among rural areas and towns of all sizes. Traditional industry could be found in households and workshops supplied by water power. Prior to the 18th century, there were a few factory-like operations while waged labour, and industrial slavery, existed. In the late 18th century, however, the industrial revolution and the factory system set in motion unprecedented changes in the nature, scale and growth rates

THE EVOLUTION OF MANUFACTURING INDUSTRY

The evolution of manufacturing industry over historical time is often summarily expressed in the form of ‘stages of development’ models. Berg (1985) reviews two such “models of manufacture” relevant to British and West European experience in which industrial capitalism developed indigenously in long established societies. In particular, she distinguishes a marxian model of ‘primitive accumulation and manufactures’ and a ‘proto-industrial’ model x l’4bres 2.1) I further extend the accumulation process and labour exploitation by virtue of their size, more sophisticated machinery and by removing worker control over working conditions.

In the case of the proto-industrial model, the crucial second stage in the linear sequence features the ‘putting-out’ system rather than the large workshop as the dominant way of organizing manufacture prior to the factory system (Berg 1985: 77-86). In this model, rural putting-out systems pave the way for large scale industrialization, not by refining a division of labour (rural households might just as well develop polyvalent skills as specialized ones), but by the capacity of rural areas to increase levels of production (not necessarily productivity) at competitive prices. Thus the advantages of putting out systems to serve growing demands for manufactured goods from the late 16th century related to their: relative freedom from guild restrictions; access to labour which was cheap and, with agricultural change, increasingly plentiful; reliance on dispersed rural workers with a tradition of low wages and who faced difficulties in forming unions; reliance on rural workers who had access to agricultural work and to subsistence levels of food; and domination by merchants who controlled market access, the materials required in production and wage levels and who accumulated the profits and capital which in turn provided funds for industrialization.

Table 2.1

The Spread of Traditional Paper Making

Location	Year	Comment
China	105	Ts’ai Lun, an official of Emperor Ho-Ti’s court credited with inventing paper making. Oldest archeological discovery: A.D. 109.
Korea	600?	Probably transferred by Buddhist monks.
Japan	610?	Probably transferred by Buddhist monks. Considerable experimentation. Hand papermaking still important.

Samarkand	750	Two Chinese papermakers captured by Arabs in war and taken to Samarkand.
Baghdad	795	Chinese paper makers brought by Harun al Rashid to start second factory. Spread of paper making through Arab world including Cairo by 1040.
Spain	1056-1151	Introduced by the conquering army of Moors. Spain exporting paper by 1150.
Italy	1255	Introduced by Moors. Soon became exporter.
France	1326-38	A legend claims a Frenchman, who was captured by Saracens in Second Crusade and worked in a Damascus paper mill, returned with the skill in 1150s.
Germany	1320	
Netherlands	1428	Paper making did not become important until after 1586 when war with France cut off French supplies of paper. Hollander Beater invented in Amsterdam in late 17th C.
Switzerland	1450?	
England	1550s	After failure of a mill established in 1490s, Bishop of Ely sponsored Spanish paper makers and Royal Court sponsored German paper makers.
Mexico	1580	Introduced by Spanish.
US	1688	Introduced by a German immigrant, William Rittenhouse who build first mill in Pennsylvania where second and third mills built in 1710 and 1728.

Source: Library of Congress 1968; Studley 1977; Hills 1988

In reality as Berg (1985) notes, pathways towards industrialization are more complex than anticipated by either of these two models. Apart from workshops and putting out systems, traditional industry was organized according to artisan and cooperative principles while different forms of organization existed side by side or within the same industry in different places. Moreover, if the large factory has become the dominant unit of organization since the industrial revolution, the small firm, workshop, putting out systems and artisan production have never been relegated to the pages of history. As Piore and Sabel (1984) argue industrialization is not a simple linear process various parts of the Middle East from 750-900 A.D., North Africa (1100 A.D.), Spain (1150 A.D), various parts of western Europe (1190 to 1586 A.D) and from Europe to Mexico in 1580 and the US in 1690 (Library of Congress 1968). During this slow evolution experiments were made with different materials and, for example, the Spanish introduced a water powered 'stamping' mill (to reduce raw materials, mainly cloth rags, to fibres) in the 12th century. About 500 years later, the Dutch developed the Hollander Beater which required less power and was four times faster than the stamping mill.

After 2000 years of development, paper making in 1800 existed as a workshop based activity located adjacent to streams for water power and close to towns which provided supplies of rags and markets. At this time, the workshops varied in size although most were small and paper making remained a labour intensive process, more art than science (Roberge 1972). Within just 100 years, however, as part of the industrial revolution paper making was transformed into a capital intensive activity organized in large factories by radical technological innovations in the paper machine and in wood fibre-based pulping processes. In this industry, as in others, the process of creative destruction had begun. In geographical terms, as pulp and paper manufacture migrated to remote rural locations, specifically those accessible to the coniferous forests of North America, Northern Europe and Russia, craft forms of production declined and paper making in metropolitan centres became more specialized (Hunter 1955). Moreover, the areas, to access recycled paper. In turn, pulp and paper production in the 'old' coniferous regions has been forced to restructure or disappear (Mather 1990; Marchak 1995)

Many traditional industries were embedded in agricultural regions and exhibited different forms of organization to paper making. An example is provided by the English woolen industry, England’s most important industry, its chief source of wealth prior to the industrial revolution, and found in every region of the country. Forms of organization, however, varied considerably, including between the two leading producing regions, namely the West Riding of Yorkshire, where the domestic system dominated, and the West Country (south-west England), where the putting-out system dominated. There were some workshops in both regions. The two regions also experienced different transitions with the factory system (Table 2.2).

Table 2.2

The Organization of Traditional Industry: The English Woollen Industry_

	Domestic System	Putting out System

Division of Labour:	Within family, live-in workers and community.	Within family and community.

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In contrast to the domestic system, which was dominated by small independent producers, the putting-out system in the woolen industry was organized by merchant manufacturers. Merchant manufacturers, who became important in the West Country at an early stage in the industry's development, owned the wool, cloth, and ultimately even the equipment, as well as being responsible for marketing. The merchants 'put-out' the wool to workers who specialized in a particular process for a wage from the merchants. These workers typically relied more on farming than the Yorkshire artisans either as land owners or increasingly as farm labourers. Indeed, as harvests failed or agricultural wages were reduced these workers were often forced to borrow from the merchants, using their equipment, such as a loom, as collateral. Consequently, over time merchants gained control over the entire production process which in turn encouraged class alienation between capitalists and workers. As workers became more dependent on the merchant their wage levels became more vulnerable, a situation particularly acute for town dwellers. Not surprisingly, worker complaints and violent disputes were more common in the West Country than in the West Riding prior to the industrial revolution (Mantoux 1928; Berg 1985).

During the 18th and 19th centuries the evolution of the woolen industry in the two regions varied in a manner reflecting the general and rapid shift of industrial activity in Britain to the North. Bearing in mind that wool remained the country's dominant export during the 18th century a massive switch in the industry occurred in this period as Yorkshire increased its share of the country's output from 20% in 1700 to 60% in 1800 (Berg 1985: 125). Moreover, the industry's evolution at this critical time is neither consistent with the primitive accumulation model, since workshops were not a dominating feature, nor the proto-industrial model, since the region (the West Country) where the putting-out system dominated did not become the centre of factory production. While some large factories were established in the West Country these too failed. In contrast, in Yorkshire, the growing centralization of woolen production in factories was achieved by both artisan and capitalist forms of organization. Thus woolen factories in this region were created by artisans in the form of ‘cooperative mills’ containing machinery each could utilize, a form of organization which lasted until the 1850s, and by numbers of waged employees performing highly specialized tasks under the strict supervision and control of specialized management and the clock (Chapman 1972; Watts 1987: 37). Some of these features were evident in some traditional industries especially those comprising workshops, 'mills' or 'early factories which utilized water power to produce relatively standard products with waged labour. After the 1760s, however, the factory system increasingly dominated existing and new industries and the biggest factories operated on an unprecedented scale in terms of size and number of machines. Initially, the factories relied on water power. Subsequently, the innovation of the steam engine by James Watt in 1769 (the first patent date), made practical at Mathew Boulton's Soho works in Birmingham, opened "the final and most decisive stage of the industrial revolution" by providing reliable power at any location (Mantoux 1928: 337).

The factory system did not suddenly replace traditional forms of organization as an inevitable consequence of 'machine' imperatives which required large investments, power sources and centralized production. Traditional and factory systems, in the cotton as well as woolen and other industries, existed side by side for decades. In the case of Arkwright's factories, which contained over 1000 spindles, the water frame had originally been designed as a s-0.0007rcBfactengine 7hor fram

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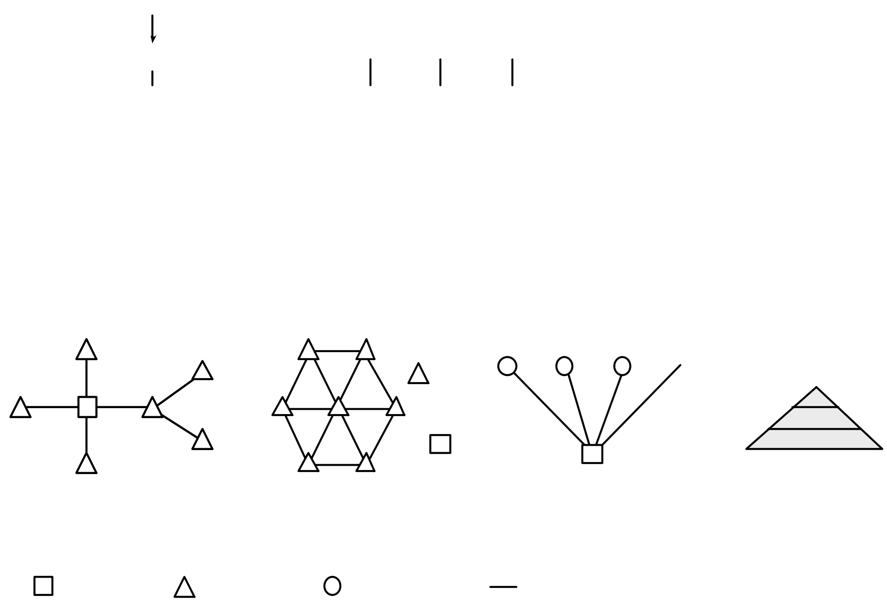
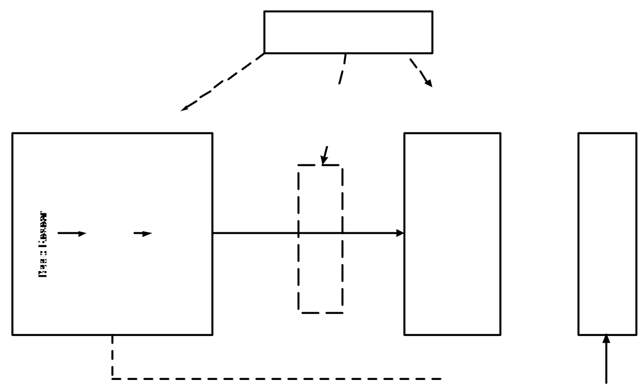
25% of the factories employed less than 100 so that "Extremely small firms fitted in besides the giants. Some were single process firms; others combined several processes. Some were multistoried mills with an assembly line type of organization. Others were a combination of shacks and workshops" (Berg 1985: 230). In activities with limited markets, such as the framework knitting industry of the East Midlands, the factory system was not the 'end point' of the industrial revolution but a degraded putting out system featuring sweated labour.





> the great technical inventions, including the most important invention of all, the steam engine, had all become practical realities. Many factories were already at work, which apart from certain details as to tools, were identical with those of today (1927). Great centres of industry had begun to grow up, a factory proletariat made its appearance, the old trade regulations, already more than half destroyed, made way for the system of itself even then doomed ...... The law which inaugurated factory legislation was passed in 1802. The stage was ready set...

Perhaps 'doomed' is too strong a word to use in relation to , that great radical idea of economic thought developed by Adam Smith (1776) to extol the virtues of an economic system driven by principles of competition and profit with minimalist government intervention (and no regard for custom and tradition). Mantoux's point is that the relatively raw version of was soon modified by an increasingly complex set of social and institutional initiatives, beginning with government legislation in the form of the factory acts which 'interfered' with business behaviour in terms of such basic issues as a minimum age for employment and length of hours worked in a week. As Polyani (1944) articulates, capitalist societies, as others, are regulated and in the 19th century the purpose of these regulations was to ensure that an economic system motivated by remained a society. Nevertheless, whether was doomed or regulated, at the end of the 18th century 'the stage was ready set.' The industrial revolution, in association with the agricultural and transportation revolutions, established capitalism’s most striking characteristic, that for self-generated change (Heilbroner 1992: 25).

INDUSTRIALIZATION AS A PROCESS OF CREATIVE DESTRUCTION

Industrialization as the engine of capitalism has long provoked different interpretations, beginning with the classical economists, notably Adam Smith (1986) and Karl Marx (1978) and their contemporaries writing in the last decades of the 18th century and first half of the 19th century. While both Smith and Marx recognized labour as the source of value and wealth they offered distinctive visions of the implications of the capitalist-based industrialization process for labour and economic development. According to Smith, the basic means by which production is increased is through an increasing division (specialization) of labour and the introduction of machinery. As Smith anticipated, industrialization within the framework of capitalist society has been a major source of 'the wealth of nations.' In general terms, the use of more specialized, productive labour created larger outputs which in turn required an expansion of markets and for markets to operate efficiently. In Smith's view, markets work best (most efficiently) when they are regulated by freely competitive processes, that is the principles of laissez-faire. So long as governments could ensure that capitalists themselves did not restrict competition, a natural expression of self-interest according to Smith, the market forces of demand and supply would continually stimulate an efficient allocation of resources. Competition thus simultaneously encourages individuals to pursue economic

185-7). In the case of the circuit for money capital, for example, the formula is (Marx 1986: 109):

M—C......P.....C'—M'   where,

capitalists start the process by using ('transforming') money (M) to buy commodities (C) and these commodities are then further transformed in a productive process (P) which creates ('transforms') new, more valuable commodities (C') which in turn can be exchanged for a larger sum of money (M') that began the circuit. The difference between C and C' and M and M' is the surplus value created by exploiting workers who are always exploited because they inevitably receive less in wages than they provide in value of output (Barnes 1990: 995). Marx offered similar formula for productive and commodity capital. In general terms, Marx's vision of industrialization is dominated by a circular process in which the metamorphoses of capital are based on the realization of surplus value (Figure 2.2). As Marx emphasized, the circuits of capital faces inherent contradictions which are ultimately expressed in massive crises as capitalists over-invest to create excess capacity and, instead rely more and more on exploiting labour to extract surplus value thereby immiserating the working classes. For Marx, economic injustices can only resolved when workers regain the means of production.

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recessionary crisis. While the particular timing and length of each cycle or wave, and the number of severe recessionary crises varies among the models, Kondratrieff (1978) provides a widely cited model.

For Kondratieff, industrial evolution since the late 18th century has

There is empirical support for the idea of long waves of industrialization, although somewhat different periodizations do exist (Freeman, Clark and Soete 1982; Freeman 1982; Gordon, Edwards and Reich 1982; Mensch 1979; Mandel 1980). Explanations for Kondratieff waves nevertheless vary. According to Mensch (1979), each new wave is created by the clustering of basic innovations which stimulate massive opportunities for investment and employment in new branches of industry (see Abernathy and Utterbach 1978). In the initial phases of each Kondratieff wave technological changes focus on employment and market expanding product innovations. Over time, as markets for the new goods become saturated and as investment increasingly favours process technology to reduce labour and material costs, a combination of excess capacity and decreasing demand creates a crisis Mensch labels "technological stalemate." The way out is another cluster of innovations. From this perspective, the first clustering of innovations occurred in the iron and textile industries, the second clustering in steam power and railways, the third in electric power and chemicals, the fourth in petrochemicals, electronics, autos and aerospace, and the fifth in micro-electronics.

Mensch's view, however, has been criticized for its technological determinism, because available evidence does not support his idea of the clustering of innovations and because the evolution of leading industries is more complicated than anticipated by this model (Chapman and Humphrys 1987; Freeman, Clark and Soete 1982; Freeman 1982; McArthur 1987). Freeman (1987) outlines an alternative approach, based on recognizing shifts in techno-economic paradigms, that suggests that long waves of economic activity are more broadly based and embedded within society (Freeman and Perez 1988; Perez 1983; Marshall 1987). This model has several key features. First, economic development is generated by technological and institutional changes which form the basis for each long wave. Second, industrialization is a secular process which becomes increasingly complicated over time. Third, industrialization is characterized by economic crises which in turn help stimulate transformation. Fourth, economic transformation is led by particular 'leading edge' economies and industries. Finally, fundamental economic changes occur to realize productivity advantages that could no longer be obtained by previous arrangements.

Shifts in techno-economic paradigm

To help understand technological change and its wider impacts on society Freeman and Perez (1988: 45-7; Freeman 1982) distinguish incremental innovations, radical innovations, new technology systems and techno-economic paradigms. Incremental innovations occur more or less continuously within industry and typically occur on the initiative of engineers and workers directly engaged in production. While no single incremental innovation has dramatic effect, over a period of time the cumulative effects of incremental innovations on productivity are extremely important (Cohen 1984; Hollander 1965). Radical innovations, on the other hand, occur unevenly over time, space and sectors and have dramatic impacts which create new markets and the basis for investment booms which support the growth of new products. Even so, the impacts may be localized around these new products. Changes in technology systems, which combine radical and incremental technological innovations with organizational and managerial innovations, have broader impacts on several branches of the economy and create new industries. The cluster of innovations in synthetic materials, petro-chemicals, injection moulding and extrusion machinery and related applications that occurred from the 1920s to the 1950s provides an example (Freeman, Clark and Soete 1982).

Changes in techno-economic paradigms occur when new technology systems exercise effects throughout the entire economy. New techno-economic paradigms include new product and process technologies which in themselves form new industries and also affect the input cost structure and conditions of production and distribution in the economy as a whole. While new techno-economic paradigms evolve out of the downswing phase of the previous Kondratieff wave because of some decisive advantage the shift from one paradigm to the next inevitably involves structural crisis and

of the new technologies and new forms of organization (especially factories) while transportation was facilitated by canals and turnpike roads. The steam engine and machinery industries also grew rapidly and became the dominant industries of the next long wave. With each new long wave, the leading industries change and others are created while existing industries, including by adopting features and attitudes of the main carrier branches, adapt and grow, sometimes rapidly. Each wave, in other words, adds layers of new activity and infrastructure while simultaneously forcing changes in existing structures.

It might also be noted that the diversification of industry over successive long waves extends to resource manufacturing as well as secondary manufacturing industry. Thus, entirely new branches of resource based industries, other than those associated with power generation, have been created since the industrial revolution. The aluminium industry, for example, dates from around the beginning of the second Kondratieff and the modern pulp and paper industry dates from around the beginning of the third Kondratieff.

Interdependencies among industries (and other sectors of the economy) is a vital feature of the industrialization process. In the early mechanization techno-economic paradigm, textile factories stimulated the textile machinery industry which was fed by the developing iron industries while both textile and iron factories provided markets for the newly developing steam engines. In the steam power and railway techno-economic paradigm, the close connections that developed among the coal, iron and steel, railroad, and heavy engineering industries provided the core of the industrial agglomerations that developed in the UK, the US and Germany. As Freeman and Perez (1988: 47-9) emphasize, so-called 'key factor' industries play a vital role in the creation of new techno-economic paradigms and the establishment of broadly based industry interdependencies.

The success of new paradigms is based on 'decisive advantages' which for individual firms are in the form of productivity improvements. The factory system and mechanization of the early mechanization techno-economic paradigm, for example, created internal economies of scale, that is declines in average cost with increasing size of factory, not possible in traditional industry. As Adam Smith (1986) noted specialized workers performing the same task on the same machine on a continual basis provided a basis for scale economies by working faster, learn tasks more readily and encouraging use of specialized machinery (Figure 2.5).

development of new sources of power, materials, machinery and power tools, factory organization and transportation systems which allowed cheaper access to larger markets

Ford's innovations greatly reduced the need for skilled workers (fi9l Tw( )Tj32.6s

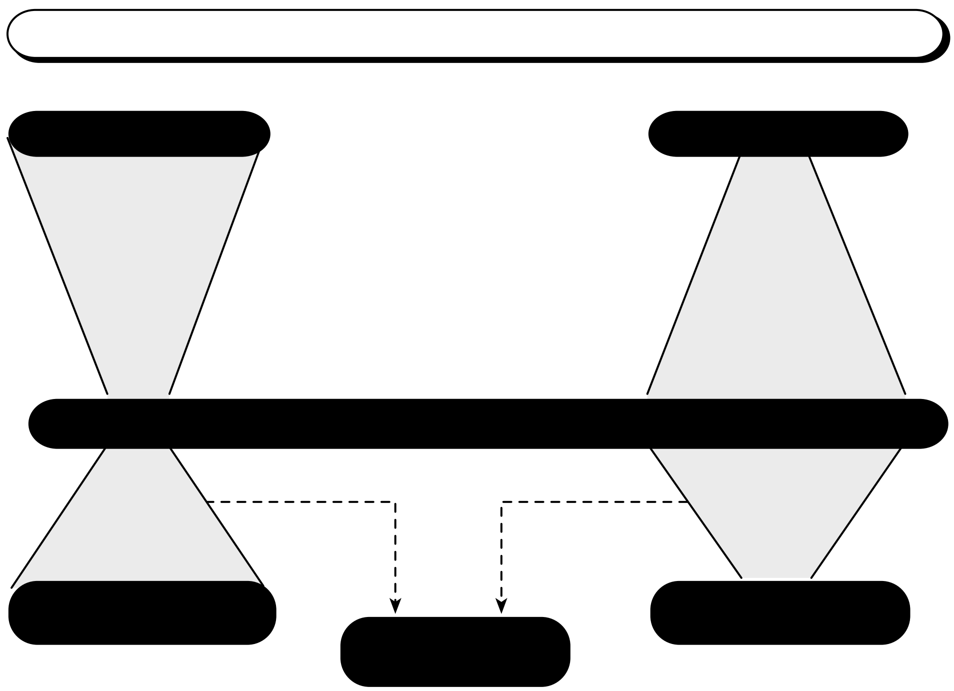
In addition to technological change each paradigm is implicated with new forms of international and national systems of regulation (Figure 2.4). In terms of national regulation, for example, in the latter part of the 18th century laissez-faire constituted an intellectual attack on feudal and medieval restrictions on trade, whether in the form of guilds, tolls, monopolies, privileges and restrictions on apprentices and worker movement. Instead, laissez-faire sought the liberalization of

2. Steam power and railway	Entrepreneurs	Foreman. Drive system	Engineer and Inventor-entrepreneurs
3. Electrical and Heavy Eng.	Captains of Industry	Taylorism	Inventors plus In-house R&D
4. Fordist mass production	Technostructure	Industry Unions and Collective bargaining	In-house R&D Govt R&D
5. Information and Communication	Collaborative networks	Union/non-union Factory/firm level bargains	In-house R&D Factories as labs Collaborative R&D

Sources: Columns 1 and 4 based on Freeman and Perez 1988; column 3 based on Gordon, Edwards and Reich 1982.

In terms of business organization, for example, successive paradigms feature the

specialization, also labeled craft production, and systems of mass production (Figure 2.6).



technological options, however, do not depend primarily on efficiency but on the interests and 'visions' of those organizations and individuals who control investments and resources in society (Sabel and Zeitlin 1985: 161-4). Moreover, once chosen and supported by infrastructure, a particular technological trajectory develops accumulating advantages which limits other possibilities. For Piore and Sabel (1984), especially in the US, it was the mass production option that became the dominating vision, culminating in the development of the assembly line and related techniques by Ford. Even in the US, however, SMEs remained important in the economy and in the 1970s a "Second Industrial Divide' (Piore and Sabel 1984) marked a major transformation signaling the re-emergence of systems of flexible specialization, including flexible mass production in which high volumes are combined with product differentiation and MNCs rely extensively on SMEs for components and services. Globally, however, the history of the articulation between flexible specialization and mass production varies considerably.

The flexible specialization thesis has had a considerable influence on current debates on industrial location and regional development and it does offer a more detailed and variable account of economic history than that of the techno-economic paradigm model. Yet, there are significant points of overlap between these two models. Both suggest that there are transformations or turning points in history even if one has more than the other. Both stress the interweaving of technological and institutional change even if relative explanatory emphasis differs and both consider history vital in understanding economic behaviour. Finally, both models emphasize that since the 1970s industrial countries have experienced fundamental change from models dominated by mass production to ones dominated by flexibility.

FROM FORDIST MASS PRODUCTION TO FLEXIBLE OR LEAN PRODUCTION

Under fordism, the typically planning system is horizontally and vetically integrated (Figure 2. 7a). That is, these firms (horizontally) produce similar products in different factories and they (vertically) manufacture and supply the inputs associated with technically linked operations (Figure 7. 1). That is, production is dominated by

(ch. 13). Ford, for example, sought to pursue principles of

1989). In practice, flexible labour can take on very different characteristics (Storper and Christopherson 1987; Hayter and Patchell 1993; Patchell and Hayter 1995).

Towards more flexible workforces

Under fordism, the typical large corporation, and its subsidiaries and factories, structured work by professional 'white' collar, production 'blue collar' and secretarial 'pink collar' workers along strongly hierarchical lines (Figure 2. 7a). The technostructure occupies the top part of the hierarchy. At the pinnacle itself is the chief executive officer (CEO) and/or corporate president, below which are executive vice presidents (VPs) representing particular functions (finance, sales, R&D, production), products and geographic areas. Below the VPs are further layers of management with each layer reporting directly to the layer immediately above it in the hierarchy. These layers may include assistant VPs, directors, senior plant managers, maintenance managers, assistant managers, superintendents and assistant superintendent. Each of these professionals would supervise secretarial pools of various sizes. Positions such as foreman and group leaders often occupied positions at the interface of the technostructure and the (unionized) blue collar workers who in turn were further layered by seniority and department in which the most senior member of the group would exercise a degree of control over the others.

A defining feature of fordist hierarchies is the highly specialized nature of work tasks among professionals and blue collar and pink collars. Indeed, Taylor's ideas of scientific management or Taylorism exercised a pervasive effect on work organization in planning system firms under fordism (Table 2. 5). As noted, the thrust of Taylorism is to sharply demarcate job tasks by production workers to realize productivity gains from the specialization on simple, repetitive tasks which simultaneously increases the chances for automation (Urry 1986). As such, Taylorism required a substantial supervisory layer to ensure that work task were met and to provide the 'thinking' if decisions had to made.

According to Taylor, the costs of supervisory bureaucracies were more than offset by the benefits of worker specialization. Thus, jobs between workers and professionals were discipline were sharply separated and 'segmented' (Doeringer and Piore 1971; Edwards 1979; Gordon, Reich and Edwards; see also Kerr 1954). Within each segment, particular job tasks were typically highly compartmentalized. Moreover, under fordism, collective bargaining between management and unions institutionalized this structure.

The bureaucracies and work structures of fordism started to break down in the 1970s and 1980s. One of the key advantages of fordist corporations seemed to be their stability. By the 1980s, fordist stability was seen as rigidity as fordist corporations encountered increasing difficulty in coping with the dynamism of the ICT techno-economic paradigm. Atkinson (1987), for example, argues that in response to recession, increasing uncertainty and technical change, an increasing number of firms have sought to become more ‘flexible’ with respect to employment (chapter 12). At the same time, firms have sought flatter decision making r(s w0.0A,ughsi5)s w0.0A,ugosw.s1(work stru(Fig st 2. 7bpter Fe

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Clearly, from society's point of view, there is a great deal of difference if communities are dominated by functionally or numerically flexible workers.

From linear to loopy R&D

Under fordism, intellectual skills are concentrated among white-collar workers including R&D employees who have the responsibility of supplying technology in the form of new products and processes to meet the specific production and marketing needs of the firm. Moreover, under fordism, R&D itself is a linear sequence of specialized (and separate) processes involving basic research, applied research, development research and technology transfer (Figure 2.8a). Lutz (1994), for example, illustrates R&D (and production) in the US auto industry from the 1950s until the 1980s as a set of chimney stacks each of which provided a self contained department responsible for a specialized range of tasks which when completed were passed on to the next chimney and with virtually no formally planned interactions between chimneys. From this perspective, R&D, like production, benefits from specialization and economies of scale (Vernon 1970).

In flexible firms, in-house R&D is organized differently (Figure 2.8b). In particular, flexible firms seek to develop 'loopy' forms of R&D which plans on the close, on-going integration of different aspects of the R&D process and between the R&D process and production and marketing. Lutz (1994), for example, illustrates R&D (and production) in the contemporary US auto industry in the form of 'platforms' which integrate all the processes from R&D to marketing for each product. In this model, which is based on Japanese experience, feedback is expected and production workers are also expected to play a role in the innovation process. Indeed, dominant firms are information intensive and seek to link "design, management, production and management into one integrated system - a process which may be described as 'systemation' and which goes far beyond the earlier concepts of mechanization and automation" (Freeman and assembly line. More flexible workers became better skilled, more fully employed, more interested in their jobs and more likely to suggest improvements. In addition, the flexibilities permitted by the newly emerging electronic control systems of the 1970s could be readily integrated within a system of manufacture already oriented to lean production and flexibility. It might also be added that in more general terms Toyota represents trends occurring throughout many Japanese industries and it is Japan that has emerged as the technology leader of the ICT techno-economic paradigm. Such a shift, unthinkable in the west two decades ago, confirms again the dynamism of the manufacturing sector.

CONCLUSION