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## **The importance attached to machines in division of labour Facts and debates. A brief critical history**

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Automation is an historical phenomenon that can only be understood taking account of the contexts in which it is developed. The automatic principle (a mechanism that triggers another according to a third) has long been known and applied in various fields by very different societies. However, the increasing automation of the production of tangible or intangible assets is part of a process of technical, economic and social change that has its origins in the eighteenth century in Europe.

When the first automatic machines were introduced in factories after the Second World War, the questions concerning technology were reactivated. What was the impact on labour, on national growth, on industrial societies and on capitalism? The question to know if productive techniques were neutral, malleable, determining or determined raised examining each of these areas. Immediately, the discussion developed in the frame of age-old debate on the division of labour. Did the development of automation allow to progress in this debate?

Observers, analysts and theorists have noted, from the beginning of capitalism, a strong development of the division of labour in correlation with market expansion and technical development. Next to the anterior division in independent activities, a new form of division of labour clearly appeared in capitalist manufactures. Production of a complete product by a master-craftsman and his companions was replaced by a production made by skilled workers, specialized in one part of the product and using new tools. The master-worker, placed under the authority of an entrepreneur or manager, became their coordinator and the assembler-finisher.

Adam Smith (1723-1790) had seen in this new division of labour only a logical extension of the division into independent businesses, the two forms resulting from the universal human propensity to exchange. On the contrary, Karl Marx (1818-1883) distinguished radically the two forms, a century later. The division of labour within the capitalist enterprises took, he said, a specific form, the division of design and execution that is to say the intellectual division of labour. This type of division of labour was deepening through tools and machines designed to obtain this result. Marx gave evidence for the division of labour in mechanized factories. The master-worker disappeared in favour of the engineer and the foreman, and the skilled worker specialized was replaced by the professional worker on machine and the labourers. Gradually employees lost the power to organize their work. The intellectual division of labour allowed the employer to uphold its objectives and priorities. Showing that, Marx changed the approach of the division of labour and of machinery. The machines for capitalist enterprises are above all designed to divide intellectually the work. Therefore, he strongly criticized those who then (including Pierre-Joseph Proudhon, 1809-1865) saw the mechanization as a miraculous tasks regrouping that the manufacture work division had previously separated.

Emile Durkheim (1858-1917) and Max Weber (1864-1920) criticized the Marx's interpretation of the division of labour that was for them too "economistic". They highlighted the uniqueness of Western countries compared to the "primitive" societies or to other civilizations. For Durkheim, the division of work, specializing and differentiating the individuals, created between them a system of rights and duties go far beyond the economic sphere. The division of work imposed a social bond, characteristic of modern societies, which made them at once autonomous and interdependent. Durkheim considered the fragmentation of tasks into elementary operations as an abnormal and temporary form of division of labour. He believes that this form could be eliminated by the formation of professional groups involving employers and workers.

On the contrary, Max Weber tried to understand the specificity of the division of labour in modern Western societies. The typology of "relationships to the world", that he has developed from the main religions, led him to conclude that only the West had developed a type of rationality, both in the fields of law, economics, of political science and techniques, for the predictability of human actions as physical phenomena, through the enactment of laws, regulations and procedures imposed on all. The capitalist work organization and administrative bureaucracy were to him as subsets of a particular culture.

These broad interpretations lost their relevance from the First World War in the twentieth century, because of the considerable acceleration of the division of labour with the diffusion of special machine tools and the generalization of mechanized assembly line. The generalist engineer then began to be replaced by the research and development department of products and production methods, composed by engineers, designers, technicians and preparers of work. The professional workers on machine and the labourers disappeared in favour of skilled maintenance workers and unskilled production workers.

The emerging sociology of work, represented notably by Elton Mayo (1880-1949) and Georges Friedmann (1902-1977), showed the limits of "rationalization of work" in terms of efficiency, and its consequences for work, employees and society. Simultaneously, researchers in ethnology, prehistory and philosophy began to analyse the tools and the machines as products of a culture or as mediators of social ties (George H. Mead, 1932).

The modernist euphoria that took hold of part of the population with the development of mass consumption in the 1950s, however, upheld an optimistic view of the future at the mid-1960s. Automation, if one believed the observations made in metallurgy, steel and chemical industries, in transport and in information processing (Touraine 1955, Mallet 1963), would be able to free workers from doing uninteresting and physically exhausting elementary operations and give them more intellectual tasks of control, maintenance and analysis. The fragmentation of tasks, which characterized the work until the 1970s in industry and in services despite the beginning of automation, was, in this vision, a regrettable but necessary step to eliminate empiricism prevailing in the workshops and offices and to help to design automatic machines.

The automation thus raised the same hope that mechanization did a century earlier, despite the denial by history. The same error was made: to use the intellectual division of labour as a descriptive notion, and not as a concept that can see the social process beyond the appearances. However, other points of view were expressed. For some researchers, there was no general trend caused by "technical progress", but different degree of division between conception and execution according to local or sectorial balance of power (Naville 1961). In this case, the productive techniques were either neutral or shaped by this balance of power. For others, the technical changes, inspired by a rationalism and an utilitarianism unique to the West, engaged companies in a questionable way (Friedmann 1966). For still others, only the strategic and organizational choices of firms were important (Crozier, Friedberg 1977). The technical change was a fact that no one could escape.

The crisis of work and of productivity, that marked the capitalist countries at the turn of the 1960s and 1970s, has again revived research and thinking about capitalist division of labour. It led to a questioning of the work organization and production techniques, as well as the moving line as the first CNC machines, the automated subway or computers. A wave of "critical" researches rose: from the denunciation of "damage of progress" to the theorization of capitalist division of labour via the impeachment of "Taylorism".

The denunciation of "damage of progress" and the impeachment of "Taylorism" left open the possibility to reorient the "progress" or to abandon "Taylorism". On the contrary, the theory of capitalist division of labour, based on the Marx's analysis, stated that the division of conception and execution, through work organization and technical change, was a necessity for the expansion of capital-labour relationship and a specificity of this social relationships. The intellectual division of labour was for the capital the means to reduce the uncertainty of work, even if it can never be eliminated completely. The "capitalist automation", far from restoring an understanding and a mastery of the production process by the employees, reduced at contrary their discretion and intervention (Marglin 1972, Braverman 1974, Freyssenet, 1974, Noble 1984).

The oil and monetary shocks of the 70s led employees to change quickly their protest priority. The priority was not the intellectual content of work, but the job itself. However, the institutional actors (employers, unions, governments, various agencies) not realised immediately the level of the competitive crisis. They tried to respond late to the work crisis of the beginning of 70s. The emphasis was on improving working conditions. The denunciation of "Taylorism" even became a theme developed by a part of employers. But only some companies actually have lengthened the cycle time in assembly line and regrouped the tasks in workplace and offices that advocated socio-technical school of Tavistock Institute (Trist et al. 1963) or of Swedish Universities.

The second oil crisis in 1980 led to abandon these attempts in many countries. Automation, computerization and robotization were then presented as the only quick and effective solution to improve both working conditions and to make the necessary leap forward in productivity, as the recent Japanese competitiveness seemed to prove. Number of firms thought they could thus not only catch up they supposed delay in this area, but even overtake the Japanese by adopting the most advanced techniques. They designed automated and integrated workshops called flexible, which, far from boosting productivity, were a source of many losses, because they were not sufficiently controlled. The public debate on the machine and the job restarted (Sauvy 1980). Unemployment actually flew, but not in all the countries, especially in the countries previously export-oriented as Japan, Sweden, and Germany.

However, one could learn concerning both technical change and work organization from the wave of automation of the first half of the 80s. Far from adopting only one type of work organization, the enterprises experimented with a variety of forms. Indeed automation changed the stake of production. The challenge was not to obtain from employees to produce themselves a given products volume as before. The new stake was to obtain from employees they controlled the automated machines producing in their place to prevent or minimize the automatic shutdowns caused by defects, errors or failures. This function could be achieved in several ways. The more deskilling way was to entrust to an operator to apply a predetermined procedure of recovery after automatic stoppage of the machine and to document the incidents so that the maintenance department could later research and eliminate the causes. The more up-skilling way was to constitute a team of technicians, maintenance workers and operators, collectively in charge, not only to ensure the regular flow of production and the quality, but also especially to try that the machines became more reliable without delay. Between these two extreme ways, a spectrum of work organisations has been observed.

So some people thought possible a lasting reversal of the intellectual division of labour and concluded that the productive techniques were finally socially neutral. But, as we showed later, this variety of work organizations was a very brief moment in the automation process. Concerning the working conditions and the intellectual content of tasks, the more optimistic people was the more disappointed. The automated machines effectively used in enterprises did not suppress all the most arduous tasks and all the operations under time constraint. Operations, such as the loading and the unloading of pieces, or as the visual control of products on line, remained unchanged. The tasks, previously requiring know how and skill, as the tool change and adjustment, the geometrical check of products, the reworks were simplified by the design of machines. Operations under time pressure continued to be attributed to unskilled workers. The intermittent tasks, intellectually simplified, were assigned to the monitoring operator who became officially in France a “manufacturing professional”, but far from the level of skill of maintenance workers (*Sociologie du Travail* 1984/4).

After the disappointing results of the leap forward in the automation, the management discourse changed completely, with the support of some Japanese and American academics (Aoki 1988, Womack et al. 1990). The competitiveness of Japanese firms was no more considered as a result of their level of automation, but as a result of their management model. The intelligence of the employees would have been, in their opinion, mobilized daily to reduce waste and thereby to reduce costs. The "Taylorist-Fordist" model was dead. The "lean production" took its place. It was able, according to them, to be able to solve both the crisis of labour of 70s and the productivity crisis of the 80s. The miraculous new business model quickly convinced many of researchers, who criticized “Taylorism”.

From that time, the debate on productive techniques seemed to be no longer relevant in many scientific publications. It was unclear to the reader if the productive techniques were considered endogenous or exogenous to the changes in organization, and in the latter case if they were neutral or critical.

The debate focused on the origins of the varied forms of change. Then there was a flurry of proposals. Without being able to name all the authors and their works, the organizational choices made by the companies depend on the ability of the workers to accept the constraints (Burravoy 1979), on the national institutions, specially learning institution (Maurice et al. 1982), on the national culture (Dore 1986, Aoki 1988), on the type of demand (Piore and Sabel 1989), on conflicts and arrangements between local actors having changing interest and different professional cultures (Bijker et al.1989, Callon Latour 1991), on dominant industrial model, Taylorism-Fordism versus Toyotism (Coriat1991), on "conventions" between actors (Salais and Storper 1995, Eymard Duvernay 2004), on the new stage of capitalism based on finance (Coutrot 1998), on the "spirit of capitalism" able to use to its advantage the critics against it (Boltanski and Chiapello 1999), on a plurality of renewed productive models, updating the capital-labour relationships (Boyer and Freyssenet 2000), etc.

Alongside these trends, the neutrality of productive techniques thesis reappeared in some announcements of the "end of work". According to them, unemployment would become structurally a mass unemployment because of enormous productivity gains made possible by automation. Unless a mad scramble to invent and produce more and more goods, unnecessary and ecologically disastrous, the productivity gains could only reduce the necessary labour time. So the free time would be a structural characteristic of social life in the future, and the intellectual division of labour would disappear progressively with the full automation of goods production and of services (Gorz 1988, Rifkin 1995, Méda 1997).

Nevertheless some events, experiences and new researches have led to a better understanding of the place of production techniques in the evolution of work. Among the forms of organization that emerged in the first half of the 1980s, the most skilling forms for employees, not only did not diffuse, but they disappeared progressively.

Two reasons have contributed to this evolution. First, the design of the automated machines impeded the workers team to reliable quickly these machines. Second, the Engineering department refused to change the design to continue to control the reliability. So the few skilling organizations existing in automated workplaces, gradually disappeared in favour of the deskilling forms. The more frequent of deskilling forms was that we described previously. Simplified tasks for tool changes, for control, for first maintenance or rework, etc., were attributed to semi-skilled operators, and the maintenance work was divided in three levels. For the first time, the maintenance workers, who were previously the backbone of the labour movement, saw their work intellectually divided. The limited and temporary reskilling of monitoring operators was the means to deskill the maintenance workers. (*Technologies, Idéologies, Pratiques* 1991, *Techniques et Cultures* 1994).

The labour crisis at Toyota in 1990 (Shimizu 1999) and the bankruptcy of some Japanese car makers during the Asian crisis in 1997 showed that the diversity of Japanese firms was at least as great as that of firms in other countries (Fujimoto 1997). The model that was considered as the best model, the Toyotian model, met its own social and economical limits of possibility and viability. To face the work crisis, Toyota had tried to give more meaning to work, that the fight against waste had not given. For that, Toyota engineers went in Europe to find inspiration in the socio-technical experiments of some firms. By the time everyone had eyes only for the "Japanese model", Toyota observed what happened other ways, especially the most successful of them: Volvo Uddevalla plant. In this plant, two workers were able to assemble, in fixed station, parts and subsets, transported by automated guided vehicle, to built a complete luxury vehicle in less time than needed on an assembly line (Ellegard K., Engstrom T., Nilsson L. 1990; Sandberg 1995). This system demonstrated that mechanical or computerized line was not a technical or cognitive necessity, but a means disciplining workers. Indeed the "reflective production", characterizing the Uddevalla plant, required to continue a social compromise, based on the continuous and programmed reversal of the intellectual division of labour that has begun. Beyond the particular circumstances of the abandon of this system in Uddevalla plant, it seems to me that the absence of social compromise to support Reflective Production was a structural one (Freysenet 1998).

Both types of research were realized to settle the question of endogenous or exogenous nature of automation in the changes made by companies. The first analysed the design process of automated systems, computer programs and expert systems in enterprises to identify the assumptions and objectives of designers. The second aimed to verify the possibility to design and use machines from other economic and social pre-requisites. While some assumptions expressed the engineers culture in the country concerned, others presuppositions directly corresponded to the requirement of labour control by simplification and predetermination of human intervention. Conversely if we assumed that the employees were not the problem but the solution, one could organize an automation process and a design of technical forms based on other priorities: automation of simple and compelling operations, including supplies and handling operations, design of extrovert and adaptable machines, complex tasks attributed to skilled workers so that they identified all the parameters and hazards occurred during the production process and they participated directly with engineers to automation process. Doing that, the intellectual division of labour could be reversed by job enrichment based on the new competencies and by progressive equalization of status (Daniellou 1986; Greenbaum, Kyng 1991 ; Freysenet 1992).

The debate about technology, through researches on labour and automation, progressed because the participants renounced to discuss about the technology in general, but about concrete techniques designed and implemented in different social contexts. The social endogeneity of the productive techniques seems to be today widely accepted. From the technological determinism, dominant in the past in many researches, we have moved to the analysis of the social genesis of production techniques actually used. The production techniques have a direct influence on the intellectual content of work by the objectives and assumptions underlying their design and their use. The debate remains open, it seems to me, to know what are the social determinants of these objectives and assumptions.

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