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TECHNOLOGICAL CHANGE: NECESSARY ORGANISATIONAL STRATEGY THAT AFFECTS WORKERS

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The first part of this article proposes the concept of Technological Change, with regard to new technologies, considering its nature, extent and purpose, as well as a historical dimension. In the second part, we describe the process of technological implementation carried out in a particular industry, motor car manufacture, placing special emphasis on human resources policy. Finally, we present the results obtained with regard to the perception those involved in the organisation have of this technological change, the importance of setting up training programs and communication channels, with a view to reducing the negative effects perceived by the workers themselves, and the possible consequences for workers' professional development.

En la primera parte de este artículo se propone el concepto de Cambio Tecnológico, cuando se hace referencia a las Nuevas Tecnologías, a partir de la reflexión sobre su naturaleza, alcance y fines, anotaciones históricas incluídas. A continuación, segunda parte, se describe el proceso de implementación tecnológica llevado a cabo en una organización industrial - fabricación de automóviles - subrayando el esquema de actuación seguido en lo referente a la política de recursos humanos. Finalmente, se exponen los resultados obtenidos, en el estudio realizado, sobre la percepción que los productores de esta organización tienen sobre este cambio tecnológico, la importancia de establecer programas de formación y canales de comunicación, como procedimiento para aminorar los efectos negativos percibidos por los propios trabajadores, así como las consecuencias previstas sobre su desarrollo profesional.

The problematic nature frequently attributed to technology in relation to its economic, social, labour and organisational implications has constituted, since the very beginnings of its development, the nucleus of scientific thought. Forty years ago, Drucker (1960), put it lucidly: "Everyone who writes about technology recognises the extraordinary nature of the number, variety and complexity of the factors involved in it and which are, in turn, influenced by it: economics and the legal system, political institutions and social values, philosophical abstractions, religious beliefs and scientific knowledge. No-one can know everything, and even less so handle it in their relationships, which constantly vary. And nevertheless, all of that forms part of technology in one way or another, at one point or another (p.157).

In any case, whether it be admitted tacitly or explicitly, the theoretical formulations about the elements making up technology, its development and, finally, its extent and purposes, included in what have constituted the three main currents of study – deterministic, critical/dialectic and hermeneutic/pluralist (not forgetting other approaches, understood as socio-economic, based on descriptive/prescriptive approaches (Luján and Moreno, 1996)) – , reflect options of value and ideological assumptions that, beyond their empirical demonstration, have a decisive influence on the objectives of scientific work and the design of research hypotheses. And indeed, from a different reference framework, "*they should contribute*" substantially to the construction of "social representations" drawn, using their own technology, by different social actors – managers, unions, workers, etc. – and this will eventually condition and mediate their behaviour with regard to technological innovation.

Why the expression "*they should contribute*" instead of a stronger statement with regard to the implications and consequences of the myriad of references and empirical works on "the technological discussion"? Given the need for an intellectual critique, we can state that the application of doctrine from the social sciences has been limited, and even scorned; this has led, indeed, to a situation in which an enormous quantity of theoretical contributions has had a minimal influence on the activity, both at everyday and strategic levels, of companies and organisations. In a pertinent and original analysis, refer-

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ring in particular to the Sociology of Work, Castillo (1994, p.409) considers "that it appears incapable of having its knowledge applied, fails to connect with society and 'dies of success', on its scientific knowledge becoming dissolved and converted into the common sense of each society"; in a similar line, Villena (1997), in a lucid reflection, defines it and contextualises it, in a wider sense, in terms of the well-justified retrospective consideration of classics which, as he underlines, "…are unfortunately relegated to more or less philological readings, mistakenly written off as irrelevant and outdated". Whether or not the present work constitutes "just another study of technology" or, in line with the work referred to by Villena (1997) or the research of Castillo (1996), it is considered as an attempt to underline the need for pluridisciplinary approaches in wide-ranging and complex problems (such as those faced by a company in relation to technological change and innovation), is up to the "applier" more than the researcher himself.

RESEARCH CONTEXT: AN ORGANISATION IN THE PROCESS OF TECHNOLOGICAL CHANGE

As stressed by Castillo (1996, p.55) "the normal or standard context of the discussion and literature on technological transfers, or on the now-famous transplants, tends to revolve around the importation of new forms of work not only to countries called (somewhat inaccurately and ironically) semi-peripheral, but also to completely peripheral ones – almost always from countries referred to as central, or dominant."

The present work is based on the research carried out in relation to the technological change occurring in an industrial organisation –that of motor car manufacture. This is a sector of the automotive industry that is undergoing considerable technological modifications – Advanced Manufacturing Technology – that make it a relevant area for the study of the relationship between technological innovation and labour organisation (Castaño, 1994). Let us briefly consider the changes occurring in these organisations as a direct result of the most recent technological developments.

In sum, behind technological change in the industrial production of motor cars are factors such as the need to meet increasing demand and tougher competition for the world market, where Japanese manufacturers lead the way, though recently other Far Eastern and eastern European countries have come onto the scene, with extremely favourable levels of productivity and quality and costs. Within this competitive context, western European and American producers have been obliged to make substantial modifications to the manufacturing process, with the aim of reducing costs, boosting productivity and increasing quality.

The Spanish car industry has not remained immune to such changes, even though, from the organisational point of view, the advances have been much slower. In fact, productive flexibility has not led to the overcoming of Taylorism, but rather to a breaking up of the productive chain into shorter series, with limited integration and grouping of tasks in particular job posts. The results of the study by Castaño (1994) on the main effects of technological change in the Spanish car industry in the last five years provides definitive and conclusive data. According to that study, the transformations have affected:

a) *Work tasks*: producing a regrouping of tasks, direct production activities having been reduced and indirect activities – maintenance and quality – increased. Physical effort has been substituted by technological development, but at the same time, the everyday activity of the worker has become more complex, with higher levels of autonomy, decision and responsibility.
b) *Professional categories*: with the substitution of the concept of professional category by those of function and multi-skilled workers. Functional categories emerge and acquire relevance, such as those of auditors, programmers of receipt of materials, work team and quality control coordinators. Also, there is a clear tendency for the unification of Direct Labour (DL) and Indirect Labour (IL) teams.
c) *Qualification requirements*, functional mobility and training: these result from the demand for multi-skilled workers, so that, for example, specialists constitute a category directly under threat, given their lack of a wider training, which reduces their possibilities of reconversion; on the other hand, this situation favours medium-level technical groups, whose level of general training is much higher, and who have much more positive multi-skill indices. Increased mobility in all modes, and modification of training policies, which focus on three types: maintenance operators – training in the handling of new technology; middle managers or foremen – work team leaders and human relations; and administrative staff, engineers, senior managers and directors.
d) *Working conditions*: the high average age of workforces has given rise to considerable problems of adaptation to the demands of new technological and

organisational systems. Of particular relevance has been the problem of retraining workers whose experience, though great in terms of time, is limited to carrying out simple, monotonous and routine tasks on production lines. On the other hand, technological innovation has permitted the automisation of high-risk production processes, leading to a reduction in traditional health problems related to hearing, the skin and the back, and to fewer accidents. Nevertheless, other problems have emerged, related to the new working conditions, and especially to increased responsibility, greater job uncertainty and insecurity and more flexible and irregular working days: stress, depression, alcoholism and cardiovascular problems.

e) *Changes in labour relations*: from closed schemes in relation to specialisation and assignment of tasks, highly structured and formally defined professional categories, within a legal framework that determines and conditions labour organisation (working hours and shifts, wage conditions, etc.), to a flexible, open system as regards both planning of work activity and the relationship between employer and employee – with more "personalised and individual" working and contractual conditions.

In line with these changes, in the Renault organisation it was decided in 1988 to adopt a "strategy for change", using as a pioneer factory the assembly and manufacture plant at Valladolid so as, on the basis of the results obtained, to generalise the design of the new manufacturing systems to the Group's other factories. Thus, a series of actions were implemented for the application of procedures, methods and techniques in the production line (quality groups, creation and development of Basic Work Units (BWUs), progress acceleration plan, "just in time" techniques as procedures for the provision of materials, and flexible-tight manufacturing systems), together with the drawing up of a Social Plan – as set down in the 1989-93 Agreement document of the Inter-Centre Committee signed by the company and the Committee – outlining the following strategic Human Resources policies:

1- Reduction of workforce, with the laying off of around 6,000 workers – 30% of the total – through early retirement and voluntary redundancy schemes.
2- Development of criteria to favour labour flexibility through the development of schedules and timetables for production and personnel mobility and rotation with the aim of adapting production to market demand.
3- Training plan: involving a schedule designed to improve quality, establishing the mean of 112 hours per year for each employee within the Training/Quality Project.
4- Management schemes: determining the human resources potential with the aim of drawing up the professional development programmes of the company's managers from the year 2000.
5- Implementation of non-retributional motivational actions favouring the creation and development of groups participating as basic units in the organisation of human resources.

As a result of the technological innovation and the introduction of the Social Plan, the change in the production line was truly revolutionary, leading to considerable organisational readjustments. There were also important developments from an economic point of view: the manufacture of the new engine "E1600" – Energy – involved a total investment of 68,000 million pesetas (420 million euros) with the following production specifications: new design combining reduction in consumption with lower pollution indices, increased efficiency at levels of 8-13%, lighter structure and higher quality levels. For this design, the engine-building plant was reconverted, bringing full automation to the production line through the introduction of computerised and electronically-guided controls, including the following systems: Integrated Manufacturing Assistance (*Ayuda Integrada de Fabricación*, AIF), Monitoring of Production Line Breakdowns (SEPAL), Statistical Quality Control (SPC) and Productivity Control and Maintenance (TPM). In this way, it was possible, at each stage of the production chain, to detect possible deficiencies and faults, cutting down on maintenance tasks, reducing the length of line breakdowns and increasing the availability of other production instruments.

As far as the relationship between technological innovation and staff reductions is concerned, the problem is to establish a deterministic causal link insofar as both the elimination of tasks and the contracting of services and materials from outside constitute measures that favour reduction of the workforce. Nevertheless, the joint examination of the economic investment carried out in technology in the period 1988-1991 in the factories producing Engines 1 and 2 – Table 1 –, the period of maximum investment in the last decade, and the development of the workforce in the years 1992, 1993 and 1994 in the same factories – Table 2 – permits us to see the situation clearly:

As it can be seen, the reduction of the labour force in the Engines factories was progressive, significant and sequential, from a temporal perspective, in relation to the economic investment made in technological development. Another relevant piece of data, in relation to Engines 1, is that this loss of staff corresponds, during 1992, to Direct labour (DL), less qualified assemblers and machiners, whilst in 1994, on the other hand, there is an increase in DL in the same department, as a consequence of the compensatory effect of the fact that Indirect Labour (ID) – better qualified and whose role it was to help DL – becomes converted into DL (and thus reduced in number).

The final analysis of the production balance also leaves little room for doubt: the effective production ratio rose from 70.2 workers per 100 engines in December 1989 to 27.8 workers per 100 engines in December 1997 (Graph 1).

Table 1
Investments (millions of pesetas)

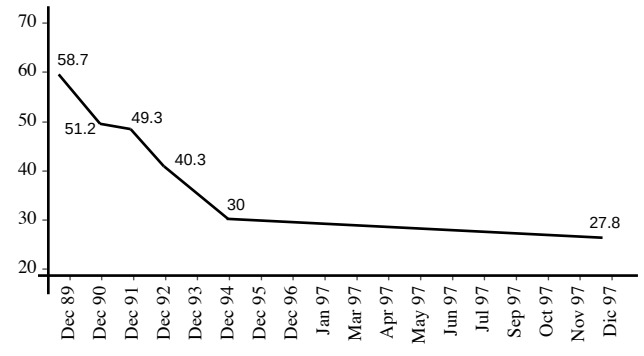
CONCEPT	1988	1989	1990	1991
Industrial investments	18,992	13,441	13,756	17,731
- Vehicles	9,513	4,020	3,208	5,626
- Mechanical components	2,620	1,469	531	-----
- Quality	827	589	300	1,062
- Administration	35	33	42	44
- TECHNOLOGY	5,997	7,330	9,675	6,999
Non-industrial investments	5,395	4,684	3,271	3,781

Note: 1 million pesetas = 6.100 euros

Table 2
Evolution of Human Resources (Engines 1 and 2)

	1992		1993		1994	
	ENG 1	ENG 2	ENG 1	ENG 2	ENG 1	ENG 2
DL	858	966	459	871	495	845
IL	426	838	343	380	294	307
ML	140	142	122	134	102	121
TOTAL:	1,421	1,491	924	1,385	891	1,273

Graph 1
Ratio of workers/manufacture of 100 engines



Following these strategic lines of economic investment, production design and human resources, there began to be implemented a new model of labour organisation based on the setting up and development of Basic Work Units, aimed at favouring and maximising the participation and involvement of workers. Briefly, from an operative point of view, production units comprising a maximum of 20 workers each were created, in productive processes in which the result/final product of their work could be accurately identified and in which client-supplier relationships were established with the rest of the Basic Work Units. Thus, as can be seen in Graphs 2A/2B, the training and development of the Basic Work Units is begun in the Area of Production and Manufacture at the end of 1991, to be implemented throughout the factory in 1994, through its introduction in the service areas. Currently, it is being definitively consolidated on the basis of homogeneity criteria, resulting in its reduction in quantitative terms and its grouping in functional terms:

A decisive role in this organisational change has been played by the training policy with the definition of strategies for the entire workforce. Thus, as shown in Graph 3, the training received by each worker has been carried out in a parallel – in increase and decrease – to the creation and implementation of the BWUs:

METHODOLOGY

The present work was carried out within the framework of the following questions "How do the workers perceive this process of technological change?", or "What strategies has the company followed with the aim of reducing the possible effects of this technological transformation?". These were the basic issues that guided our work, in relation to the subjective experience of the workers themselves on the production line.

Sample

We selected a sample of 148 workers from two departments – Engines 1 and Engines 2 – in which the levels of technological change differed: the Engines 1 department, responsible for the manufacture of the new engine, was equipped with full application of the Advanced Manufacturing Technology (AMT) and the incorporation of computer-assisted programmable robots; in Engines 2, mechanical production line technology was employed for the manufacture of engine parts, with AMT lines in their initial stages of installa-

tion. The sample therefore included workers belonging to departments with technological transformation levels at different stages: 101 workers from Engines 1 (high level of technological change) and 47 from Engines 2 (initial stage of technological change).

As distinguishing characteristics of this employee group we would highlight the fact that they belonged to the professional categories "Specialists" and "Grade 2 Officers", with an age range of 45 to 55, average length of service of 20 years, union affiliation rate of 35% (the majority with the UGT union), and a proportional distribution among them of Direct Labour (DL) workers and Indirect Labour (IL) workers. Let us recall that DL is directly involved in the production and manufacture of the product, whilst IL is made up of workers that carry out tasks of maintenance and control, assisting the DL workers.

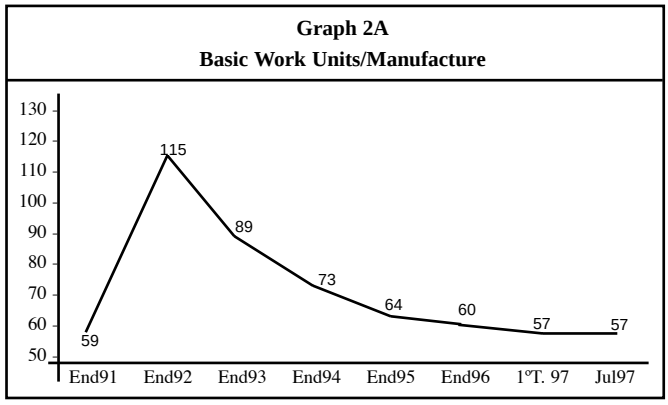
Procedure

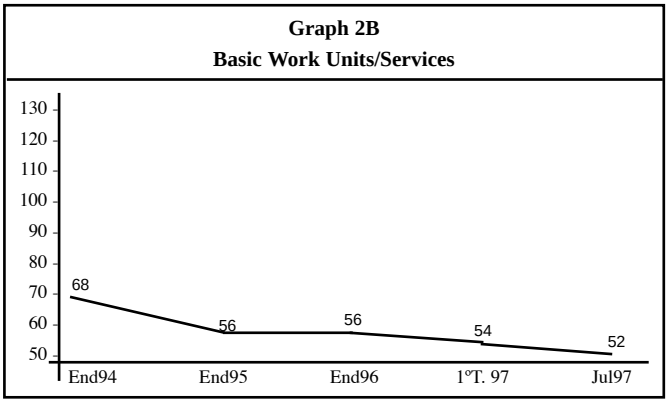
The approach employed was, first, direct and structured observation at the production line in relation to the design and organisation of the work activity; second, individual interviews with: a) the workers themselves, and b) those responsible for each department, from the highest level – senior managers – to those with direct responsibility over workers – middle managers or foremen; in a third phase we carried out semi-structured interviews and group discussions with the workers themselves, in groups of 6/8 workers; finally, in a fourth phase, we administered the scales and/or questionnaires on General Stress Level (*Nivel de Estrés General*, López & Valverde, 1984), the State-Trait Anxiety Inventory (STAI, Spielberger, 1988) and the Perception of New Technologies Scale (Chao and Kozlowski, 1986).

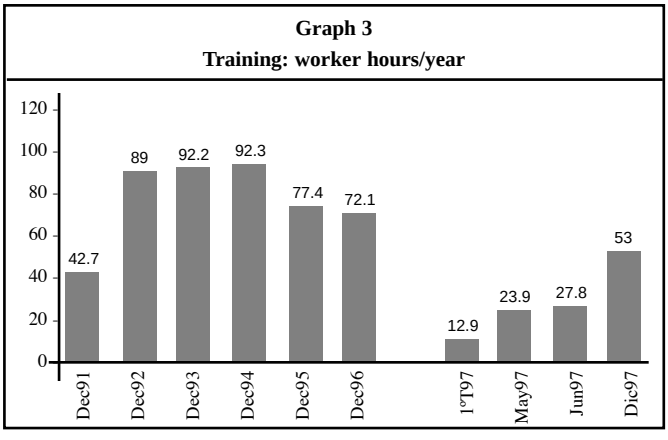
ANALYSIS AND DISCUSSION OF RESULTS

From the content analyses carried out on the interviews with the senior and middle managers it was observed how their comments reflected unanimous recognition of the comprehensive and significant technological innovations, both at a work organisation level and, with a negative influence, in relation to the workforce in each factory. In the latter case, however, interviewees admitted that they perceived the Social Plan and the need to reduce production costs as fundamental variables in relation to staff cuts. Nevertheless, there appears to have been some difficulty in identifying clearly the concept of New Technology given that, in addition to including the electronic equipment and automated lines – that which directly affected production –, they also understood as new technology the computerised management systems and all the support components for the production line.

A significant aspect in the managers' mental scheme was their perception of the change in the organisation of the work and its implications for the workers themselves, insofar as each worker had gone from being responsible for a machine to controlling a high-tech production line. This, in the managers' view, had involved two changes: less physical effort and increased mental/psychological tension in workers, resulting both from the level of responsibility acquired and their self-perception of being "controlled": in the event of breakdowns or dysfunctions of the production line, direct personal responsibility can automatically be attributed. In







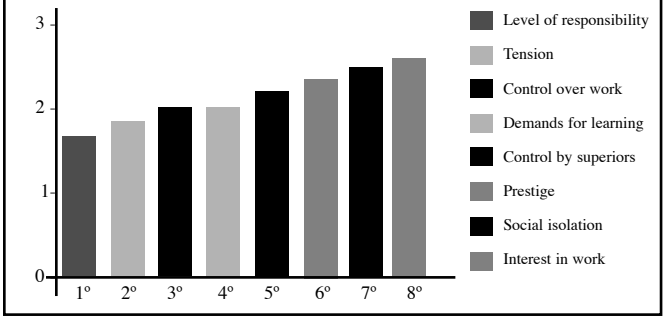
sum, the managers were describing a problem of workers' adaptation to the technology of a psychosocial nature (workers' self-perception of feeling controlled) rather than training-based one.

As regards the remarks made by workers, both in the individual interviews and in the group discussions, a first conclusion was universal: technological investment, labour instability and staff cuts were stages of the same process, accentuated by their lack of basic training and by a lack of communication – or credible communication – on the part of the company about the strategy and plans of action to be implemented. In sum, technological innovation and reductions in the labour force were considered as inevitable and irreversible facts.

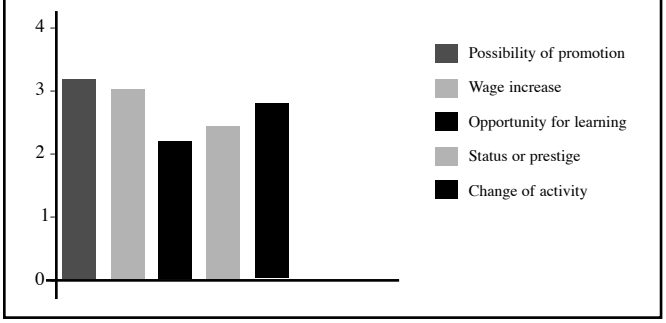
A second significant concern was related to the increased mobility and rotation resulting from the introduction of new technology, which caused stress and uncertainty, since it involved not only learning of new tasks, but also leaving one's work team and changing/adapting to a new one with unfamiliar norms, rules and activities, despite being in the same factory and/or department.

Moving from the analysis of the comments made in the interviews to the examination of the data provided by the workers on the scales and questionnaires, the first aspect to be underlined is the level of intensity perceived in relation to the content of their work when they begin their new activities with the Advanced Manufacturing Technology. As can be seen in Graph 4, level of responsibility, stress, control over one's own work and learning demands are the most significant variables, reflecting the importance of cognitive factors in work tasks related to new technologies, which involve greater levels of vigilance, attention, comprehension and psychological implication on the part of workers.

Graph 4
Perception of Technological Change Effects on Behaviour



Graph 5
Technological Change and Career Development



Nevertheless, the levels of affectation are not the same in all workers: indeed, in a more detailed analysis, by means of an analysis of variance, we found significant differences in relation to professional category (p=.0283) and type of production line (p=.0645), with increased responsibility and higher stress levels perceived more intensely by specialists and in workers on automated lines. These two groups, it will be recalled, are precisely those that are in closest contact with the technology; moreover, in the case of specialists, they are directly responsible for the maintenance and regulation of the advanced automatic technology.

The introduction of new technology is also perceived in positive ways by workers. As can be seen in Graph 5, they perceive the technology as positive both in relation to learning opportunities and to the prestige of the workers operating it. Their perception with respect to the possibilities of promotion, wage increases and changes in tasks are more neutral, though not negative. Thus, the perceived effects of technological change in career development are more favourable in what we can refer to as the expressive dimension (identity/prestige, learning/knowledge) than in the instrumental dimension (promotion, salary/incentives).

If up to now we have stressed workers' perceptions in relation to the effects of technological change, we should like to highlight, finally, those factors that the workers themselves described as critical for reducing the negative effects of such change. In this regard, the results of the ANOVA show that the company management's concern (p=.0432) and the organisation of training in new technologies (p=.0619) are perceived as critical factors by the workers in Engines 2, precisely the department in which the initial phase of technological change was implemented. It was in this same department that workers were most worried about the low level of company management concern over the appropriate organisation of training (p=.0289), confirming the conceptual line that stresses the importance of companies' styles of implementing new technologies, which should aim to involve the workers themselves (Korunka, 1993).

CONCLUSIONS

In the light of the results obtained, our suggestion is that approaches to resolving the much-debated triangle Technology/Work Instability/Psychological Welfare of workers in technological change processes should have a twofold dimension: on the one hand, such processes should involve adequate planning in relation to the introduction of the technology, with workers being offered clear training schemes, information/sensitisation programmes and simulation activities with the specific technology that permit the establishment and development of their levels of technological self-efficacy; on the other hand, and particularly in the case of Advanced Manufacturing Technology, we suggest that, within the procedural strategy, there should be increased participation of workers in the design of tasks developing as a result of technological innovation, with the aim of facilitating the creation of personal cognitive strategies and skills for the resolution of the new problems arising.

At the present time, fortunately, there is no doubt over the efficiency and effectiveness brought about by the implementation of technology, whatever the type of organisation; nevertheless, doubts do arise over whether the application of technology is maximised in relation to the economic investment made and the real possibilities of its exploitation. Frequently, company management is keen to introduce it in as short a period as possible, often failing to take account of two factors: the time required by technological systems to reach full operational capacity and the preparation and training of workers with a view to its efficient use. Thus, for example, the time employed by a worker when s/he asks co-workers for help with the use of software – probably due to a lack of training and/or communication from middle or higher managers – constitutes a labour cost that is not taken into account when investment in technology is studied. In referring to workers' comments on the company management's lack of concern over training in new technology, in the present work we have attempted to underline this aspect.

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