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A socio-technical approach for improving a Brazilian shoe manufacturing system

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Abstract. This article presents a macroergonomic intervention in a footwear company in Rio Grande do Sul, Brazil, to improve both the quality of life of the employees and productivity by optimizing the traditional Taylor/Ford work organization. Multi-functionality and team working were implemented as means of making tasks more flexible and richer and the working hours were changed. The results showed a reduction in human and material resource costs and a consequent improvement in health and workers quality of life. Although middle managerial staff displayed strong resistance to the project and to breaking traditional production paradigms, the socio-technical system has been implemented throughout the plant and is expected to end up becoming the benchmark for other companies in the sector.

Keywords: Macro-ergonomics, footwear industry, organization work.

1. Introduction

In 2007, Brazil was responsible for 5% of the world's footwear production, ranking third among the largest shoe manufacturers (after China and India responsible for 64% and 6% of the production, respectively) and sixth among the largest exporters [1]. In 2010, Brazilian footwear industry consisted of 8,2 thousand factories, employing 348,700 people producing 893,9 million pairs of footwear per year, of which about 16% is set aside for export (34% to South America, 24% to North America and 24% to Europe) [3]. In 2009, the state of Rio Grande do Sul, considered the most important shoes manufacturing cluster in the world, employed 110,766 workers in 2,762 industries [2]. Workers have low qualification and productivity [25,32], and production is highly dependent on manual work done with machines and low technology equipment and minimally skilled (or unskilled) labor [16,25,27]. As is to be expected from the Taylor/Ford system adopted in most companies, the level of injuries is high [28], the annulment of tacit knowledge makes accidents at work more likely [30], and the poor nature of the work ends up reinforcing turnover and absenteeism [26,32].

The ergonomics literature on shoe manufacturing, which goes back to the late 50's [35], suggested that automation was not likely to spread rapidly, and ergonomics would concentrate on the redesign of sewing machine controls, the selection of operatives and the study of production control systems. Singleton [35] was right, because still nowadays the shoe manufacturing remains very dependent on human manual work, carried out in risky workstations and work organization (due to the tools and machines used and the time spent on repetitive work) what leads to high risk of work-related musculoskeletal disorder (WMSD), and under dangerous environmental conditions when high risk chemicals are used (like glue and solvents).

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Studies on shoe manufacturing focusing on WMSD were developed by [5,21,23] in Japan, by [33] in Mexico, by [4,14] in Italy, by [11,12,15,36] in the USA, by [31] in France, by [28] in Brazil, by [13] in Romania, and by [19] in Cuba. Most studies concentrate on the evaluation of environment, tools and workstation conditions (i.e. microergonomics), the studies at the Red Wing Shoes [12], at the Hanover Shoe Company [12] and in the Cuban shoes manufacturer [19] being the only ones reporting an ergonomic intervention and evaluation of the work organization (i.e. macroergonomics).

Aiming to improve the workers´ quality of life, productivity and product quality, a large-scale factory in the state of Rio Grande do Sul, Brazil, agreed to restructure its production system under a socio-technical perspective. Given a backdrop of a precarious production system, with a labor force not sufficiently skilled to compete at a world level, the industrial director understood there was the possibility of the company being used as the benchmark of a more human footwear production system based on changes in how work was planned.

This paper presents the characteristics of' and a comparison between the traditional and the implemented socio-technical system.

2. Method

The 3,5 years study [29] (from May 2002 to August 2005) was conducted in one of the eight plants (the Paranhana Valley plant) of the sixth largest footwear company in Brazil, manufacturing about 22,000 pairs/month, under a Taylor/Ford production model. The intervention aimed to change the work organization and improve the environmental and workstations conditions according to the socio-technical approach that encompasses four sub-systems [18]:

1) the personnel: with three characteristics: a) the degree of professionalism, b) the demographic characteristics and c) the psycho-social aspects;

2) the technological: understood as the technology of the work system. However, as this technology has a direct connection with the work organization, in this study what falls within this sub-system are only work tools, machines, and sets of apparatus, since the type of production process and its characteristics are descriptive of the work process, and fits into the work design sub-system as follows;

3) the work design: encompasses the complexity of the company (i.e. concerns the degree of differentiation or integration within the organization), formalization (which is related to the level to which tasks have been standardized) and centralization (which refers to the degree to which the decision-making processes are concentrated within organizations). In this study, this sub-system includes: (a) how production takes place, i.e. the technology of production, b) the action of individuals on an object in order to modify it, i.e. the technology of knowledge, c) the degree of automation, rigor of the workflow and specific items of the activities or integration of workflow;

4) the external environment: deals with the survival of the company, being related to its degree of adaptability, i.e. to the environment in which it is inserted. Two dimensions of the external environment are important for this survival: the degree of change of the environment (i.e. dynamism) and the degree of complexity, which concerns the number of components of the means by which the company makes relationships.

Each of the four sub-systems of the socio-technical impacts the other, but in the case of developing countries, like Brazil, it can be assumed that the external environment is what most influences the others.

Based on the participative approach of the Macroergonomic Work Analysis (MA) [17], the characteristics of the traditional work design were evaluated and solutions for improving micro (physical environment, workstations and equipments) and macro (work design) constraints were proposed and implemented along with the company's Ergonomics Committee (COERGO) and the managerial and workers staff. The new production model was based on the ideas of the socio-technical approach of the Tavistock Group, as applied at the automotive Volvo plants at Kalmar and Udevalla [8] in Sweden, but it also considered the importance of introducing clear procedures as prescribed by the Japanese Lean system [24,34], an important contribution that was missing in the Swedish approach [8]. One hundred workers volunteered to engage in the project and were trained to work under the new socio-technical work design in a pilot line while the others eight lines continue working under the traditional Taylor/Ford model.

3. Results

3.1 Technological sub-system: characteristics of the physical environment and of the workstation

In companies that produce non-injected footwear, as is the case with most of them, the technology used is of low complexity, and is made up basically of sewing machines, punching machines, staplers, scissors, razors, knives, hatchet, pliers etc. In the company surveyed, most of the working tables do not have seats so that posture may be alternated, due to the little physical space available. The biggest problem, however, is noise (around 93dB) produced by machines, especially the punching machines.

3.2 Personnel sub-system: characteristics of the workers of the footwear sector and the company under study

In November 2002 (the month in which the prototyping of the new system began), Company's total staff comprised 1,878 employees, of whom 100 were on the pilot flow line for the study. The number of employees varies according to the configuration of the product being manufactured, which mainly varies between closed and open footwear. Usually, there is regular variation in the number of staff over a year due to fluctuations in the demand for production that is led by the situation in the market, especially the international one.

Personnel profile was obtained by a questionnaire applied to a sample of 32 workers (37.5% of the population of the pilot line), 16 from the stitching (preparation and sewing/stitching) and 16 from the assembly (assembly and finishing) sectors. Data show the predominance of women (59.3%) among workers, which is characteristic of the footwear factories in the region. Culturally, the industry considers women are better suited to jobs that involve great dexterity and fine detail in making the product. Thus, in most Brazilian factories, especially those that manufacture footwear for the domestic market, there is still the habit of assigning some specific activities to men (usually those of assembly) and others to women (usually those of preparation, sewing, stitching and review). As the activities of the stitching sector (preparation, sewing and review) end up incurring the greatest number of operations over practically all models manufactured, the staff of footwear companies that perform the complete process of manufacture mostly consist of women.

The level of education is predominantly that of elementary/primary school uncompleted (58.6%), thus confirming the characteristic of the footwear industry to hire staff with low levels of education and professionalism who end up having to accept low wages. The company has tried to reverse this situation, by having maintained a school at its headquarters since 1995, which offers a course to those above school-leaving age, equivalent to the elementary and high school syllabus. Although free, attendance is low either because, quite simply, staff do not want to study or because they do not like to, or because they are more than 40 years old and do not want to return to school desks, because they consider themselves too "old" for that, or because they would have to stay on for a few more hours sitting in a "closed" room studying and because it is already very hard to work in a factory "between four walls". Most employees come from the interior and nearby towns, where they used to work in the fields, with greater options of work and working hours in accordance both with their physiological needs and the weather (rain, sun). They come to cities which have footwear industrial clusters in order to improve their living conditions, but what they find, since most have no qualifications, is low wages and difficulties in adapting to a reality which is very different from agriculture. Depending on the personal expectations of each of them, some manage to adapt very well, while others return to the interior.

The low skills of the workforce are due to a lack of adequate induction training, with about 60% of companies not having training programs [6]. A study on 24 companies in the footwear industry of Rio Grande do Sul, showed that in only 22% of the companies is the production worker involved in a skills-giving program [32]. The most common practice is on the job training undertaken with the support of the immediate supervisor.

3.3 External environment

The "normal" shoe manufacturing scenario is one of high lay off rates due to the necessity to adjust the number of workers to the amount of sell products. The industry is highly dependent on the international market, Brazilian competitiveness relying solely upon the low price of the products offered because of the industry's low salaries [22]. However, the price of the product is set in U$ dollars, China has more competitive shoe prices and any oscillation of the international currency (i.e., when the U$ dollar falls against the Brazilian currency, the real) reduces the competing chances of the Brazilian industry. Thus, however important the strengthening of the real is for the country, the industry depends on its devaluation in relation to the American dollar otherwise the higher priced Brazilian shoes cannot compete with the Chinese ones. This scenario places the Brazilian shoe manufacturing at a disadvantage with regard to the industry´s social and safety system and to its competitiveness on the world stage.

Dependence on external market is of such a scale, that any downturn in foreign trade represents important losses of sales and consequent dismissal of many workers. In the footwear industry region of the Sinos and Paranhana valleys in the state of Rio Grande do Sul, hundreds of companies closed since the mid 1990. In 2004, the state employed over 143,000 people and in 2009, 110,766. The crisis has its roots on the competition for lower production costs, the companies closing doors in the south and opening them in the northeast of the country, attracted by lower wages and tax incentives. Some companies even open plants in India. Until 1996, the state was responsible for practically all exported Brazilian shoes; in 2011, its exports were about 21% [20]. However, human costs accounts for only 19% of the footwear costs, therefore the solution is the production of higher value shoes, for competing by quality, besides the qualification of human resources [20].

The specter of losing one´s employment generates a feeling of great insecurity in workers who begin to accept poor working conditions (i.e., the workstation and environment conditions, low wages and few guarantees of health and safety) and little by way of quality of life in general. As the region revolves around the footwear industry, there is no option and/or alternative for better jobs, and staff moves from one company to another, with similar working conditions.

Another feature of the external environment is the seasonality of the product, which ends up having enormous repercussions not only on the workers' quality of life, but also on the regional economy. The manufacture of footwear customarily occurs at two important moments during the year: the first when open (summer) footwear is designed and launched on the market and the second, when closed (winter) footwear (both boots and closed shoes) is launched. The periods of low production are the ones for developing new collections (i.e., December/January and May/June). When the responsible sector is active, while the production sector is in low demand for the product has not yet been sold. This waiting time between the development/release and sales/orders means that many companies lay off workers en masse. In the studied Company, it was the habitual practice to lay off between 700 and 800 workers in the periods of low production. Under these circumstances, being a skilled and valued professional is the guarantee for maintaining the job.

The impact of these mass layoffs, which occur in the same period in most footwear factories, ends up having major repercussions on the economy and social conditions of the population who depend fundamentally on the footwear industry. In the region, it is observed that the months in which layoffs occur correspond to the period in which crime rates for theft and assaults usually increase, which may be just possibly justified because of the lack of resources for the sustenance and survival of the workers laid-off and their families.

Another important issue for the external environment sub-system is that the laws in the country are not always followed because the judicial system is weak, as are the unions. One of the characteristics of Brazilian trade unions is to fight for (small) increases to wages and to pay little attention to labor conditions. The quality of working conditions is the responsibility of the Ministry of Labor who set up inspections through their regional branches, which do not have enough trained staff to audit all companies. Examples of the results of weak laws are the status of school/daycare center and transport. It is laid down in Article 389, paragraph 1st [10], of the CLT (the acronym in Portuguese for the Consolidation of Labor Laws) [9] that companies with more than 30 women employees need to pay a monthly allowance or build a daycare center to provide for the children of employees who are breast-feeding. However, it is the specialized unions who stipulate the amount of the benefit to be paid by convention or collective agreements and very often, the employees receive a much lower amount than expected, and for fear they would lose their jobs, they do not demand the law to be enforced. Due to this, they have to rely on the municipal kindergartens, which become over-full. As there are not enough daycare centers in the region (and most companies do not have one), parents have to work different shifts so they can work in relay on domestic tasks. School-age children are also a problem because Brazilian public schools operate in half-day periods, what makes it difficult for parents to hold down jobs with two shifts.

The region does not have a public transportation system that meets workers' needs and companies do not feel responsible for transportation. Many people walk up to more than 10 kilometers a day to go to and from work, regardless of whether it is morning, noon or night, come rain, hail or shine. Some cycle, but the road system is not designed to ensure safety whether of pedestrians or of cyclists.

3.4 Work design sub-system: traditional work system

Weak social and legal systems tend to make it feasible for weak production systems to be set up, as is the case of the Taylor/Ford model, adopted in the Brazilian footwear industry, with its high human and production costs and consequent low quality.

The Brazilian footwear industry, including the Company under study, responds to demands insisted on by clients who order small lots (30 to 50 pairs), especially when this is a question of orders for sales nationwide. The orders that fulfill international demand (export) are generally characterized by larger lots (3,000 to 5,000 pairs of shoes in each lot), but the models cover a wide range, thus leading to the feature of production by batch. The models in production may change five to ten times during a working day, which means there being a need to set up quickly in order to minimize the waste of production time. In accordance with the model to be produced, changes occur in layout, and alterations or additions of workstations, even though workers continue carrying out the same task that is, usually, assigned to them, in the same workstation, under the assumptions of the Taylor/Ford production system.

However, this type of demand for increasingly varied and smaller lots to avoid accumulated retail stocks is better supported by more dynamic and flexible systems, such as the socio-technical [8] and the lean production [24,34]. In this type of production systems, workers should have the skills they need to adjust to the variability and complexity of the richer work. But the footwear employee, with few skills to meet the demands of a flexible production process, remains in the same workstation and in the activity in which he is specialized, because training for multi-functional allocation (i.e. increasing the worker's knowledge for other tasks) is considered a factor of high investment and waste of time. As there is no training [6,27,32], the worker is afraid to try new experiences and to make mistakes, and thus prefers the comfort zone, provided by the poorer task. They say they do not like to be "at the beck and call of the assembly line flow" when there is a need for urgent allocation of more skilled workers to a given operation, especially to recently developed new models.

4. Macroergonomic intervention proposal: a new system of work from the lean, socio-technical point of view implemented in the Company

4.1 Alteration in the technological sub-system

When designing a multi-functional team working system, consideration needs to be given to safety issues related to operations that carry risks because, if they are not eliminated, a larger number of people will be exposed to them. In this context, it was observed there was a need to reduce noise by removing some machines (punching machine) since they were no longer necessary in the process, and to introduce the use of water-based glue (free of harmful to health chemicals). Another measure that limited the occupational risks was the allocation of people in groups who would operate the same machinery and equipment and have work activities that are compatible in terms of occupational risk.

Apart from this and putting in some chairs (one for two workers) for alternating the standing and sitting postures, very little has been improved in terms of technology. Even with all the preparation for team working and multi-functionality, the layout continued as a line because of the restricted space, which did not favor arranging a more appropriate layout (i.e. a more compact layout such as a U shape or circle, for example) since this would permit greater proximity among operators, thus facilitating, using one's normal speaking voice, the exchange of communications, of information and materials.

4.2 Alteration of the work design sub-system: working hours

The first major change was in the working hours. When the project started, the Company operated in two shifts (5:00 AM to 2:48 PM, and 2:48 PM to 00:17 AM) and the peak time for accidents was 6:00 AM, which was to be expected considering that this is a time when people are still sleeping, for these workers had to wake up every day at around 3:00 AM (or earlier). As there was no justification for such a schedule, the first action was to change the journey hours so that people could sleep more, and be fully awake when working. This was probably the most controversial initiative of the project, because an entire family's habits had been structured on the Company's journey hours. However, the workers recognized that the schedule was stressful, that they were tired when they were working and so were willing to try out a working day that started later (6:30 AM to 3:15 PM and 6:30 AM to 11:30 AM on Fridays) if their children were in a daycare center.

After three months testing the new journey hours, the Company found that productivity increased, but nothing was done with regard to the daycare center. Therefore, the workers claimed they wanted to return to the old schedule and did so. As productivity returned to previous levels, the Company realized that the journey change had a positive effect on production, and a daycare center was set up in the Company, operating from 7:15 AM to 4:00 PM and 4:00 PM to 10:00 PM. The definitive journey began from 7:00 AM, with a lunch break from 11:30 AM to 12:30 PM and ended at 4:48 PM.

It is stressed that this problem about the very early working day was particular to the Company under study, and not common in the region, since most follow the conventional practice of starting at 7:00 AM. and ending at 5:30 PM. Apart from the working hours, the organizational practices of the Company were exactly the same as those of others in the region.

4.3 Alteration of the work design sub-system: socio-technical work system

Generally, the range of activities, interpreted by the footwear industry as "multi-functionality" is limited to varying some operations along one line, and when there is a change of models in production. Thus, the adjustments in the process are determined by very simple technological issues, and are limited to reorganizing the arrangement and distribution of tasks according to the change of model to be produced, bearing in mind, fundamentally, their production capacity and that of the machine, to the detriment of social issues, which encompass operators' skills, knowledge and needs.

The planning and design of the new work system basically considered a working day which would be less exhausting, by work enlargement and enrichment and granting greater autonomy to the worker, obtained by implementing multi-functionality and team working. The line was not changed physically bearing in mind that the little physical space did not allow for a more appropriate layout.

The alternatives for organizing the roster of activities were based on the employees' vision with regard to the degree of ease and difficulty in performing the operations. Moreover, it was based on the study of the learning curve [7]. Given the results, the workers were able to learn a new function very easily which simplified implementing the new work system. Groups of activities to be performed were formed by proximity in the line in the assembly and the stitching sectors. Teams were formed with 6 to 8 people who, during the working day, and as they got more experience, could occupy any workstation in any group. After the fourth month, they were handling more than 25 operations.

4.3.1. Implementing the roster and forming teams

Very often, the workers who make up the groups do not know exactly the limits on their moving forward and/or back-tracking on some actions, since there is no longer traditional feedback from the former supervisors. On the other hand, the supervisors and managers (former supervisors) who start to take on the role of supporting groups instead of controlling them, also experience a critical phase of identifying with the new system. In critical situations, it is worthwhile identifying natural leaders in the midst of the groups and inviting them to help support the crisis. In this study, these leaders naturally arose and, at moments when the project was in difficulty, they came forward and participated in order to form a point of equilibrium and of sustenance for the group, besides having the role of "spokespersons" between the workers and researchers and the members of the Company's COERGO which sometimes worked on the project. In the end, teams were formed consisting of 6 to 8 people who should serve in all workstations.

4.3.2. Assessing the time taken to change function

The length of time at each workstation is an important issue because it is a marker of the time during which the employee can perform the same operation and the time for the change of activity before feeling physical and/or mental fatigue. Initially, the workers changed operation every two hours, as suggested by the immediate supervisors, until the workers took upon themselves the autonomy to make the change when it suited them. It became evident that the ideal change over time is between the second and third hour of performing the same task, and that there should be a change of operation at least four times during the working day.

This process of change being brought up about at the will of the worker was easer in the assembly sector because the immediate supervisors proved more accessible, which helped the workers to gain autonomy. In the stitching sector, a longer period of time was needed due to the supervisors´ austerity and lack of flexibility, according to the workers.

5. Overall benefits of the socio-technical system

The 100 volunteers who worked on the pilot line initially doubted if they would be able to produce under the new socio-technical system, especially because they were afraid they would make mistakes and be fired. However, due to the participative character of the research, they agreed to the study and, after four months, they had got used to the new system and no longer thought about working on the old one, since they had already acquired more knowledge and autonomy, and were therefore more satisfied with the work. On the other hand, their immediate supervisors were very resistant to the changes because they noted that due to the autonomy and greater knowledge of the process as a whole, the groups could dispense with their orders and still meet production targets.

Despite the doubts of management (who consider that specialist work is more productive), productivity increased in 3%, rework decreased in 85% and the number of spoiled pairs reduced in 69% in comparison to the other traditional lines. Accidents rates reduced in 80% and absenteeism and turnover in 45.65%. Due to the reduction of repetitive work, medical consultations and WMSD risk were eliminated.

To override the impact of external environment on the stability of the workforce, the enterprise is focusing more on the internal market, therefore being less dependent on the external one, and investing in the improvement of the personnel sub-system (by training the workers and maintaining their jobs).

6. Conclusions

This article discussed the experience of an ergonomic intervention, under the socio-technical (macroergonomic) approach, in a large footwear factory in the state of Rio Grande do Sul, Brazil. The participative research lasted for 3,5 years, the time needed to identify the main ergonomic problems, to propose solutions for improvements, to implement and evaluate them along with the Company's COERGO and the managerial and workers staff. The low level of schooling was the most critical characteristic of the personnel sub-system, while the high specialization of the tasks and low level of autonomy were characteristics of the Taylor/Ford work system design that limited worker improvement and lead to high rate of absenteeism, turnover, accidents, sickness and WMSD. External characteristics impacting the results were the wide variety and short production cycles of manufactured shoes, a result of a dependence on very irregular demand, mainly from USA and Europe, due to an unbalanced international market. The inconstancy of the market leads to high levels of unemployment, which makes workforce training a nonissue for the managers.

To override such problems, enlarge and enrich the work and cope with product diversification, a new work organization system was prototyped from 2002 to 2005 following the socio-technical model. The improvements with the greatest impact were the change in working hours, the setting-up of a daycare center to allow parents to fit into the new schedule and, especially, the resource of multi-functionality and team working. Despite the doubts of management, productivity increased, rework decreased and WMSD risk was eliminated. The results made clear that the socio-technical (multi-functional and collective) model is one of the alternatives for making the work more flexible to meet the demands of an increasingly demanding and competitive globalized market, which affects the entire footwear industry. Due to the positive results, the new work organization system is being applied to the whole factory, and about 1,700 workers are being taught to operate in teams, by the same 100 workers from the beginning of the project. It is expected the new socio-technical to be a model for other companies in the sector.

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