THE IMPLEMENTATION OF LEAN PRODUCTION AND QUALITY METHODS AT THE SHOP FLOOR: CASE STUDIES IN THE HOUSEHOLD APPLIANCE INDUSTRY

ABSTRACT

The purpose of the proposed text is to analyze the implementation of different methods from lean production and other quality methods at the shop floor of three companies of household appliances in Brazil. The research involved interviews with managers and supervisors of production, quality, and human resources department and also with shop floor workers from different production areas, in order to find out the operations management methods adopted and the workers’ involvement in their use. Many methods related to lean production foresaw the involvement of workers or even that they would be the primarily responsible for their use. However, practices adopted more recently, such as Six Sigma, don’t have the same emphasis to employees involvement compared to practices adopted in previous decades. The proposed text will examine how this issue has evolved in literature and at the companies surveyed, exploring also some potential explanations for the observed limitations.

Key words: Lean production. Quality methods. Six sigma. Shop floor workers. Household appliance industry.
1. **INTRODUCTION**

With the popularization of lean production from the 1980s onward, several studies have indicated that significant changes would occur in shop floor work division and content. The literature on Operations Management has stressed the need for workers’ involvement and that they should have more responsibilities and a more active role in decision-making.

The lean production manuals have advocated workers’ involvement or even their primary responsibility in its employment. This can be easily attested by a literature review on just-in-time (JIT) and kanban, teamwork and improvement processes, preventive maintenance and different quality-related methods. Besides lean production, certification processes, mainly by ISO 9000, have also promoted the involvement of workers.

The extension of activities performed by workers is called “functional flexibility” (Atkinson and Meager, 1986). It should be noted that work flexibility will remain as an important resource to deal with uncertainties associated with production. Despite the progress of automation, for a production system to be flexible it is necessary that workers are skilled to work with different products, operations and procedures, to perform maintenance, detect faults, and take action to correct them (CORREA AND SLACK, 1994; GERWIN, 1987; SALERNO, 1995). The assignment of these activities to workers has led to a change in hiring criteria, with greater demands on education and investment in training.

The purpose of the text is to analyze in depth employee involvement as proposed in the literature for different lean production and quality methods and how this occurs on the shop floor of three Brazilian manufacturers of household appliances.

2. **RESEARCH DESIGN**

Three household appliances factories were investigated. The factories under investigation, located in the state of Sao Paulo, Brazil, belonged to different companies and are here referred to by pseudonyms: CookCo, which produces stoves, FridgeCo refrigerators, and WashCo washing machines.

Semi-structured interviews were conducted with managers and production, quality, and human resources supervisors. The interview sought to identify production management methods adopted by the companies, the many functions performed by employees, their commitment to these methods, their educational profiles and the training they had received.

Fifty-three CookCo workers, 52 FridgeCo workers, and 52 WashCo workers from different areas of production were interviewed. The workers were asked about their activities, recent training, and knowledge of management methods adopted by the companies under investigation.
The data gathered were categorized to enable the qualitative analysis of their content. Frequencies of some categories and their interrelation were obtained with the aid of SPSS (Statistical Package for the Social Sciences).

3 HOUSEHOLD APPLIANCE INDUSTRY

Household-appliance companies produce refrigerators, freezers, washing machines, dryers, dishwashers, stoves, air conditioners, and microwave ovens (Electros, w/d). In the last decades, large multinational companies have concentrated the production of household appliances. Table 1 shows the 10 largest multinational companies, based on a 2001 top-ten ranking list, updated with information from specialized press and the Internet.

<table>
<thead>
<tr>
<th>Company</th>
<th>Country of Origin</th>
<th>2001 Ranking</th>
<th>Some Derivative Trademarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Whirlpool</td>
<td>USA</td>
<td>1</td>
<td>Whirlpool, Maytag, Amana, Jenn-Air, KitchenAid, Roper, Bauknecht, Ignis, Brastemp, Consul</td>
</tr>
<tr>
<td>2. Electrolux</td>
<td>Sweden</td>
<td>2</td>
<td>Electrolux, Frigidaire, Westinghouse, AEG, Corbeirò, REX, Zanussi</td>
</tr>
<tr>
<td>3. LG</td>
<td>Korea</td>
<td>-</td>
<td>Haier</td>
</tr>
<tr>
<td>4. General Electric</td>
<td>USA</td>
<td>3</td>
<td>GE, Dako</td>
</tr>
<tr>
<td>5. Haier</td>
<td>China</td>
<td>5</td>
<td>Haier</td>
</tr>
<tr>
<td>6. Bosch-Siemens (BSH)</td>
<td>Germany</td>
<td>4</td>
<td>Bosch, Siemens, Gaggenau, Neff, Thermador, Constructa, Viva, Ufesa, Balay, Linx, Pitsos, Profilo, Coldex, Continental</td>
</tr>
<tr>
<td>7. Liebherr</td>
<td>Germany</td>
<td>10</td>
<td>Liebherr</td>
</tr>
<tr>
<td>8. Miele</td>
<td>Germany</td>
<td>8</td>
<td>Miele</td>
</tr>
<tr>
<td>9. Indesit (Merloni)</td>
<td>Italy</td>
<td>7</td>
<td>Indesit, Ariston</td>
</tr>
</tbody>
</table>

Source: Adapted from Cunha 2003, specialized media, and the Internet.

LG, which did not rank among the top ten in 2001, has undergone significant expansion, rising to the third position. In 2005, the Italian company Merloni changed its name to Indesit, an English trade name it had acquired in 1987 (UK Whitegoods, 2005). Eco Brandt, a French company that ranked 9th in 2001, was acquired by Fagor (Spain) in April 2005, thus becoming the 10th on the list (EMCC, 2006). In 2006, Whirlpool acquired Maytag, another American company that ranked 6th in 2001 (RYBERG, 2006). In 2008, General Electric announced its decision to sell its consumer goods division, which included household appliances (CARDOSO, 2008).

In most cases, mergers and acquisitions were followed by the rationalization of organizational
structures with reduction of the number of employees and, sometimes, closing of factories (JACOBS, 2006; ROGGEMA, 2005; UK WHITEGOODS, 2004, 2005).

The main producers of household appliances are:
- China, which is now the top producer;
- Europe, where the main producers are Germany and Italy. Other producers are Slovenia, Spain, France, United Kingdom, and Turkey;
- United States;
- Latin America, where the main producer is Brazil, followed by Mexico. Other producers are Argentina, Chile, Colombia, and Venezuela;
- Japan;
- Canada (ARAÚJO ET AL., 2006);
- South Korea, which has expanded its production lines, traditionally limited to air conditioners and microwave ovens (CUNHA, 2003), to include refrigerators (APPLIANCE DESIGN, 2006).

The market for more traditional products, e.g., refrigerators, is oversaturated, especially in developed countries. Oversaturation, together with ownership concentration, has led companies to invest in production in emerging markets, e.g., Eastern Europe, China, India, Southeast Asia, and Latin America. Parent companies have invested in their own factories, joint ventures, or acquisition of local companies (ARAÚJO ET AL., 2006).

Brazilian industry was strongly affected by this international process of ownership concentration, thus becoming the target of investments of four of the largest multinationals, as shown in Table 2. In 1987, General Electric formed a joint venture with Mexican company Mabe, which holds 52% of the shares, to compete in the Mexican market and export to the USA. In 2003, Mabe took control of GE Dako, giving rise to Mabe Brazil¹, and acquired CCE in Brazil, which makes refrigerators and washing machines (PERSPECTIVA, 2005).

In 2009, Mabe acquired Bosch-Siemens plants in Brazil (FACCHINI, 2009).

<table>
<thead>
<tr>
<th>Year</th>
<th>Company</th>
<th>Acquired by</th>
<th>Resulting Trade Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>Continental</td>
<td>Bosch-Siemens</td>
<td>Continental, Bosch</td>
</tr>
<tr>
<td>1996</td>
<td>Refripar</td>
<td>Electrolux</td>
<td>Electrolux</td>
</tr>
<tr>
<td>1996</td>
<td>Dako</td>
<td>General Electric/Mabe</td>
<td>Dako, GE, Mabe</td>
</tr>
<tr>
<td>1997</td>
<td>Multibrás</td>
<td>Whirlpool</td>
<td>Brastemp, Consul</td>
</tr>
</tbody>
</table>

Source: Company websites.

In order to meet high-income consumers, companies have increased product differentiation

¹ The association involves plants in Venezuela, Colombia, Ecuador, and Peru (Andean Mabe). In 2003, Mabe also took control of Kronen, giving rise to Argentina Mabe, which, along with Brazil Mabe, constitute Mercosur Mabe (Perspectiva, 2005).
and sophistication and imported items with higher added value (ARAÚJO et al., 2006).

Brazilian capital is still present in smaller companies that do not offer customers complete lines of household appliances and their products are usually simpler and geared to the market with less spending power, e.g., Esmaltec, Suggar, Mueller, Atlasul, Latina, and others (RACHID, 2007).

Brazil’s national and regional markets (Mercosur) have attracted foreign investments. The diffusion level of appliances in Brazilian households is lower than in developed countries. In 2007, 98.1% of households had stoves, 90.8% refrigerators, 39.5% washing machines, and 16.3% freezers. The presence of freezers was larger in 2000 (18.8% of households), but its diffusion has retracted since the 2001 energy crisis (LAGE, 2004; UOL NEWS, 2008).

According to the managers interviewed, the main sales channel consists of big retailers such as Casas Bahia and Ponto Frio, which gained even more market share after retail chains such as Arapuã, G. Aronson, and Brasimac, among others, went out of business. The purchase volume of Casas Bahia entitles it to order products with specific features, to be paid by final consumers in a large number of installments whose value is retailer-determined. There are still a lot of small retailers, who buy small volumes, “five to ten pieces per month.” A couple of years ago, alternative channels have been developed such as supermarkets and hypermarkets (e.g., Carrefour and Extra). More recently, companies have pursued direct ways to sell to consumers on the Internet.

According to one manager interviewed at WashCo, sales of household appliances are seasonal, but, over the years, the use of productive resources can become steady because the greatest demand for refrigerators takes place in summer whereas those of washing machines and dryers in winter. However, Cunha (2003) states that the demand for stoves tends to follow that of refrigerators, since both household appliances are usually bought together due to a growing trend among Brazilian consumers, i.e., that of sticking to the same product line.

In 2004, this industry employed 23,800 people and its turnover was US$ 2 billion (ARAÚJO et al., 2006). In 2008, manufacturers of household appliances represented by Abinee (Brazilian Electric and Electronic Industry Association, which also includes manufacturers of portable appliances, electric manual tools, audio and video equipment, embedded electronics, among others), grossed R$ 14.7 billion, down 7% as compared to 2007. This represents 11.9% of total sales of Abinee companies, which in 2008 employed 161,900 people (ABINEE, 200?, 2009).

The production of household appliances is very much targeted to the domestic market, but the exports increased during the period in which the real (Brazilian currency) was devalued, especially between 2003 and 2004. This coincided with Argentina’s economic recovery, the main destination of Brazil’s exports of household appliances. Imports, in turn, have historically been insignificant, at around 1.2% in 1990 (CUNHA, 2003; LANDIM, 2004). With the overvaluation of
the real from 2005 onward, imports have increased and exports decreased (BANCO CENTRAL, 2006; LANDIM, 2006).

Investment by major world producers intensified the restructuring process at the leading manufacturers of household appliances. New factories were opened and existing production units either were shut down or modernized, which introduced new equipment and different production management methods, in most cases, already employed by parent companies and their subsidiaries in other countries. The following are different operations management methods adopted by the companies under investigation and how workers were involved in their use.

4 MANAGEMENT METHODS AND WORKERS

4.1 AUTOMATION AND EQUIPMENT MAINTENANCE

In automated processes, employees do not directly interfere with product transformation. They monitor equipment operation, intervening only when manufacturing parameters are outside specifications. This is one of the changes highlighted by Zarifian (2001), which he calls “the event logic,” according to which workers must be able to respond to partially unforeseen events. Work pace is no longer crucial to production volume, but workers’ responsibility increases, due to the volume of investment in such equipment and the costs deriving from breakdowns or unplanned interruptions.

Marx (1997) and Tauile (2001), while examining the implementation of automatic numerical control equipment, observed a higher workers’ involvement in tool exchange, simple maintenance tasks, and in some cases, in equipment programming. Nevertheless, Tauile (2001) sustains that many operators of conventional machines cannot become operators of numerically controlled machines.

At the manufacturers of household appliances under investigation, the automation process has involved cutting, stamping, painting, glazing, plastic injection, disposal of equipment, and transportation of components, which have employed computerized equipment. The difficulty in automating assembly entirely remains significant, despite the companies’ efforts to achieve it. Some of this automation has been prompted by the incidence of RSI (repetitive strain injuries) among assembly-line workers. At CookCo, 10% of workers suffered from occupational diseases. Given this difficulty, new tools and equipment accessories have been introduced into the assembly line, such as automatic treadmills controlled by PLC (Programmable Logic Controllers), which control the speed and stops of assembly lines and handler robots.

Among the tasks pointed out by Marx and Tauile, no worker mentioned equipment programming. Tool exchange or setup was mentioned by two respondents from the plastic injection areas of WashCo and FridgeCo. According to a person in charge of WashCo plastic section, operators...
usually help in machine setup, some of which do it by themselves. One operator from this company said that this activity overburdened him, especially when washing machine models change during production, requiring “a very quick setup” that does not take into account the occurrence of failure-related delays. This appears to be “very stressful. You just can’t fail and have to do it fast.”

The most common equipment-related task mentioned by respondents was maintenance, indicating that they had received training on the subject. The purpose of this training was to condition them to take care of the equipment and tools, inspect their operation, notify maintenance personnel when necessary, or do small repairs. A worker from WashCo metallurgy section explained that when “one gets to a sector and is going to operate a machine,” the person is instructed to “identify any noises or problems with the equipment so that production doesn’t stop.”

CookCo has also pursued a similar attitude. There, according to a worker in the printing section, “the operator makes a daily inspection. If one finds any problem, one must notify immediately.” A manager from WashCo said that he had tried to engage workers in lubrication and oil changing, regular machine cleaning, maintenance program verification, and functional machine inspection. This concern is also present among assembly-line workers, as explained a WashCo worker: “Suppose you see a small leak. Instead of letting it get worse, you fix it before the machine breaks down,” which was reinforced by a CookCo worker: “We try to keep our tools in good condition.”

4.2 JUST-IN-TIME

In a just-in-time (JIT) system, shelves or kanban panels work as an information system. By identifying stock levels of every piece or component, the system signals which piece/component production has precedence. Thus, workers are now responsible for deciding what to produce at every moment; they no longer depend on production orders (POs) from PPC (production planning and control) to know what they should do next.

As remarked by Smith (1997), JIT demands more watchfulness on the part of workers with respect to choosing the most appropriate time to produce pieces/components and controlling stock according to demand expressed by consecutive manufacturing stages, which imposes the replacement pace. Besides, according to its idealizers, the lot size is such that the pace of replacement is intense.

In spite of being one of the most important lean production methods, JIT is not widespread in Brazil; there are few fully implemented JIT systems operating in the country. Stocks are usually transferred to suppliers, as observed by Alves et al. (2003) in the automotive industry.
In the companies under investigation, its use was rather limited. WashCo managers had given up its implementation and, due to sales seasonality, did not demand that suppliers operate in this fashion. At FridgeCo plastic injection, in addition its managers’ refusal to go along with JIT, there were problems on the shop floor, whose workers, according to one manager, did not employ kanban cards to make decisions about production sequencing, which was decided by PPC. Few workers among those interviewed knew what JIT was. A WashCo worker said it was “no stock;” another said it was working “according to order.” One worker believed his company employed JIT because “it is written in many places” of the factory. Two workers said they did not remember what it was, “but it was mentioned in the last training session we attended.”

Based on these cases, it is possible to conclude that production programming is still very much restricted to the specific functional area, with little responsibility transferred to production workers in fact.

4.3 QUALITY CONTROL

One of efforts to implement the Japanese model that has drawn most attention is the adoption of diverse techniques to control quality preventively (JURAN, 1990). Some of these techniques should be applied by the workers themselves, e.g., Statistical Process Control (SPC), a technique devised in the U.S.A. in the 1920s that would only be widely employed in postwar Japan (HOFFMAN & KAPLINSKI, 1988, TOLEDO, 1987).

It is well established that efforts aimed at improving quality should commit all departments and hierarchical levels, as proposed by TQM programs, which consist of packages of statistical techniques and involvement programs that vary from one company to another and are strongly imbued with the idea of workers’ participation (ZBARACKI, 1998), despite their being employed to endorse changes not quite related to quality in some cases (MCCABE & WILKINSON, 1998).

During the 1990s, many companies pursued ISO 9000 certification. This standard advises that all employees whose work affects the quality of any given product should be trained and its implementation often leads to better training (BROWN ET AL. 1998; LEE, 1998; QUAZI & JACOBS, 2004). Even small companies have structured internal training due to this certification, as observed by Rachid (2000). In fact, training has become necessary to obtain certification, if for no other reason, at least during the audits because any worker can be asked about its procedures. Moreover, they can assist in the laborious process of documentation, as reported by Brown et al. (1998).

ISO 9000 was known by 96% of CookCo workers interviewed, 100% at FridgeCo, and 98% at WashCo. All mentioned the importance of producing with quality and reported the existence of frequent courses and lectures about it. In two cases, excerpts indicate the top administration’s
emphasis on product/process quality: “There’s a lot of pressure;” “They demand a lot; they’re very picky.” Many interviewees mentioned the weight of ISO 9000 to overseas markets: “Without these certifications, it would be difficult” to export to other countries. The environmental standard ISO 14000 was mentioned by 46% of WashCo respondents. One of them commented: “We follow it on a daily basis; we recycle” in order to prevent “waste of water, energy…” ISO 14000 was known by only three CookCo interviewees (6%), and five FridgeCo interviewees (10%).

From the 2000s onward, Six Sigma becomes popular, which, like TQM programs, systematizes a series of methods aimed at quality of products/processes, but with more emphasis on statistics (PYZDEK, 1999). CookCo had been requested by its parent company to implement it; CookCo’s CEO was often on the news media divulging the method. An engineer from the quality department was assigned to implement and coordinate Six Sigma there; for this reason, he is called “black belt master.” The company had 146 trained workers, known as “green belts,” who should participate in ad hoc groups to solve specific problems, make product/process improvements, and reduce costs.

Employees from several areas/departments were assigned to these groups, but it was observed that the participation of shop floor workers was limited. Workers knew that the company had implemented a program named Six Sigma, but few knew what it consisted of. According to one of the people in charge of the method, “this program requires users’ statistical knowledge and computer skills and just a few shop floor workers know how to turn a PC on” (Pina, 2004, p. 43). This indicates that workers’ participation may not be as relevant as was observed in the aforementioned quality diffusion programs, e.g., Statistical Process Control (SPC) and TQM programs.

At FridgeCo, Six Sigma had been implemented shortly before the research and one of the quality supervisors was in charge of both ISO 9000 and Six Sigma, which was much less known than at CookCo.

4.4 PROBLEM-SOLVING GROUPS

One of the first lean production methods to become popular in western countries was that of quality control circles (QCCs), i.e., meetings during which workers discuss issues related to their work and propose ways to improve it. Some western companies, including in Brazil, implemented QCCs in the 1970s and they became very popular in the 1980s. In 1982, 44% of American companies with over 500 employees had QCCs, 50,000 in Europe in 1987, and 600 in Brazil (FARIA, 1989; HILL, 1991; SALERNO, 1985).

Nonetheless, most of these programs were discontinued after a couple of years because, as indicated by Hill (1991), the work organization and organizational structure of companies
remained the same and top administration was not prepared to respond to bottom-up initiatives. This assessment was also shared by Hiraoka (1989) and Hull et al. (1985).

QCCs are still popular in Japan. In western countries, many companies devised similar meetings under other names (JÜRGENS, 1989; GRANDE & FERRO, 1997; RACHID, 1996). CookCo created a suggestions program, with prizes for workers or group of workers whose suggestions had been accepted, implemented, and had reduced operational costs. At FridgeCo, there was a group with “5 to 8” members coordinated by a quality technician that met once a week, an experience that could be extended to other areas. If the suggestion was implemented, those who had proposed it would receive prizes based on its financial return. WashCo had a suggestions program called “Kaisen,” of which some employees gave examples: “We implemented a treadmill” and a ladder to facilitate access to a machine.

These problem-solving groups may constitute a way of formalizing and documenting workers’ informal practices and tacit knowledge, i.e., the ins and outs of their occupation, vital to the production process.

4.5 TEAMWORK AND JOB ROTATION

One of the main references to teamwork organization is the semi-autonomous group in Sweden’s auto factories. These groups did not become popular outside Sweden, probably due to the interest aroused by the Japanese model, which ended up overshadowing other organizational alternatives to Taylorism-Fordism.

Other work group types have been reported, though, in which each worker operates different machines. It is even more usual to find models in which workers rotate among different individual work positions within the same area or among different manufacturing areas (SALERNO, 1995).

At WashCo, the term “production cell” is employed to designate segments of the assembly line in which there is job rotation, i.e., workers decide on rotation timetable and elect the person in charge of the cell, who is replaced on a weekly basis. At this company, the same line assembling top load washing machines (the most common type of washing machines in Brazil) could be set up to assemble front load ones, with the same workers. Besides, because production of freezers was low, their assembly process employed workers from another line. According to a manager from this company, “The production work teams may be assigned to one line on one day and to the line of freezers on the following day.” A worker commented: “Today we assemble one product; tomorrow we assemble another.” This flexibility is appropriate to the seasonality of this industry, but a manager remarked that this was also due to lack of parts, pointing to system malfunctioning as indicated by Salerno (1995).

At CookCo, the purpose of rotating work positions was to reduce repetitive strain injuries
(RSI), as aforementioned. FridgeCo employed job rotation in some segments of the assembly line and was planning to automate machine unloading, which would enable a given worker to operate more than one machine.

When asked about the existence of teamwork, most shop floor respondents said they were familiar with the term, in spite of referring to mutual collaboration and problem-solving groups. The idea of “internal customer” was also associated with teamwork, according to a worker: “We depend on each other. We are customers at the same time as we are suppliers.”

The workers’ involvement in the use of these methods requires support from the human resources area, what is discussed hereafter.

5 HUMAN RESOURCES MANAGEMENT

As noted by Wood and Wall (2007), the human resources practices are ancillary to production management practices. This item examines the activities of human resources that supported changes in work organization presented in the previous section.

5.1 JOB DESCRIPTION

Because the terms “versatility” and “multi-functionality” are conducive to the expansion of functions, they have been employed to describe these changes. Corrêa and Slack (1994) use the term “multi-skilled workforce,” which could also be a solution to absenteeism.

The large number of positions that formerly existed, with very narrow specification of activities, was seen as ineffective (SMITH, 1997). To facilitate the incorporation of different functions, companies have expanded job descriptions. In this vein, the position of “multifunctional worker” was created to replace specific titles for every machine operation, e.g., “lathe operator,” “CNC lathe operator,” “wood boiler operator,” and so on (RACHID, 1996). Even the Ministry of Labor has reviewed the Brazilian Classification of Occupations (CBO) to fit observed changes in the labor market, including versatility (MORAES NETO & LOPES, 2005).

FridgeCo had reduced the number of positions in the production area in order to fit the job descriptions existing in the labor market. At WashCo, a worker that had just been hired was called “manufacturing operator I.” Promotions could take this worker to “manufacturing operator II.” In this case, the description was open to incorporate different activities.

5.2 SELECTION AND TRAINING

The transference of different activities related to maintenance, production programming,
problem solving, and to different types of work groups has changed the profile expected of workers, leading to new selection criteria and increasing investment in courses and training.

Many companies have pursued to increase their level of education, either by offering formal education courses to their employees or by requiring it upon recruitment, as observed in the automobile industry by Rachid et al. (2006). Also in the general appliances industry, the education level is experiencing a gradual improvement, as shown by Table 3. The percentage of workers with a high school diploma has increased to 72.2% and that of workers with less education decreased.

### Table 3 - Educational level of workers in the general appliances industry (Brazil, %)

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Elementary school (incomplete)</td>
<td>51.9</td>
<td>26.3</td>
<td>9.3</td>
</tr>
<tr>
<td>Elementary school (complete)</td>
<td>17.4</td>
<td>22.1</td>
<td>11.5</td>
</tr>
<tr>
<td>High school (incomplete)</td>
<td>10.2</td>
<td>12.3</td>
<td>7.0</td>
</tr>
<tr>
<td>High school (complete)</td>
<td>12.0</td>
<td>28.2</td>
<td>57.7</td>
</tr>
<tr>
<td>Higher education (complete or incomplete)</td>
<td>8.4</td>
<td>11.1</td>
<td>14.5</td>
</tr>
</tbody>
</table>

*Source: Adapted from Perticarrari (2003) and Ministério do Trabalho (2011).*

Table 4 shows specific data about the household appliances industry, where the percentage of workers with a high school diploma is even higher, i.e., 75.7%.

### Table 4 - Educational level of workers in household appliances industry (Brazil, %)

<table>
<thead>
<tr>
<th>Educational Level</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary school (incomplete)</td>
<td>8.4</td>
</tr>
<tr>
<td>Elementary school (complete)</td>
<td>10.0</td>
</tr>
<tr>
<td>High school (incomplete)</td>
<td>5.9</td>
</tr>
<tr>
<td>High school (complete)</td>
<td>59.4</td>
</tr>
<tr>
<td>Higher education (complete or incomplete)</td>
<td>16.3</td>
</tr>
</tbody>
</table>

*Source: Ministério do Trabalho (2009).*

Table 5 shows the research workers participants’ educational level, 117 of which (74.5%) had at least a high school diploma and 21 (13.4%) were in or had finished college. The interviewees saw formal education as necessary to remain employed. Those who for some reason were not seeking further qualification felt guilty about it. This indicates that the workers under study had internalized the “employability discourse” (ARAÚJO ET AL. 2006, P.288; DIAS AND ZILBOVICIUS, 2009).
On the other hand, due to their having achieved higher educational levels, some interviewees indicated unmet expectations and felt frustrated because their qualifications were underused at the companies. Some of these workers expressed their intent on leaving their current jobs and opening their own businesses or sitting exams for jobs in the public service.

Training is an important way of promoting worker involvement and improving workers’ ability to use management methods (WOOD AND MENEZES, 2008). Information on training enables the assessment of companies’ efforts in implementing these methods. Among the workers interviewed, 89.7% said they had received training in the twelve months preceding the study (45 at CookCo, 43 at FridgeCo, and 50 at WashCo). Table 6 shows the number of training days that they remembered. The majority, i.e., 64.8%, recalled having attended two or fewer days of training.

Table 7 shows training topics/courses mentioned during these interviews. The most cited ones were those related to environmental and work safety issues, followed by those related to quality, especially to ISO 9000.
Over 146 people in commanding or technical/administrative positions had taken part in a training course on Six Sigma at CookCo, but no shop-floor worker had attended it. A maintenance worker said that he had only received information on Six Sigma after an auditor had approached someone in his area and asked what this person knew about it and he said he knew nothing. “It was a lapse, so this training was put up quickly for the workers to get to know a bit more about it [Six Sigma]. […] If truth be told, it was just a booklet for us to read at home”. This information was confirmed by a tooling worker, who, when asked about his knowledge of Six Sigma, said: “I have read a booklet about it, provided by the company”. Training at FridgeCo was also restricted to technical-administrative employees; no shop-floor worker interviewed had participated in it.

Thirdly in number of mentions are the technical-operational courses for production, e.g., boiler and crane operation, plastic injection, welding, assembly, design, computer science, among others. CookCo and WashCo workers mentioned many HR management courses, especially on “relations with people” and mutual collaboration. CookCo workers also mentioned courses related to production management, e.g., production planning and housekeeping, basic maintenance and cleaning.

On the other hand, it was possible to notice that course contents were not always integrated to production workers’ activities. When this happens, training participants tend to forget course contents, as in the aforementioned cases of JIT and SPC.

6 DISCUSSION AND CONCLUSION

The literature and research of the 1990s revealed that many companies followed the recommendation to involve workers in production management. This text is the result of a study that investigated this issue at three manufacturers of household appliances in the 2000s.

The focus on the household appliances industry was advantageous in investigating this issue...
because it went through an intense process of international acquisitions. In Brazil, national companies were acquired by multinationals, which favored the adoption of management methods imposed by parent companies. The study at the three companies, with interviewees from different positions, enabled the access to different perspectives on the use of these methods.

Some lean production methods were adopted in a rather limited fashion, as was the case of JIT: it was adopted by a small number of areas or for a short time, with low worker involvement even in these situations. Job rotation was mainly observed in assembly for items with low production volumes that did not demand dedicated assemblers or in an attempt to mitigate repetitive strain injuries (RSI).

It was also observed that the companies maintain suggestions programs. Nevertheless, worker involvement was more a result of the quality control methods used. ISO 9000 certification requires that workers be trained, and workers were acquainted with the preventive side of quality. This is one of the respects in which workers were more in tune with each other and with the “handbooks”, despite the few days of training that they recalled attending. It was clear that this is something demanded by supervisors on a daily basis.

Notwithstanding, worker involvement has increased only to some extent, even with respect to quality methods, and evidences show that it is decreasing. In the case of a recent method, i.e., Six Sigma, in spite of publications about it pointing to the need for worker involvement, the great emphasis on it found in preceding methods (e.g., TQM) is not present in this case. At CookCo, where this method is well established, workers are not trained in and do not know what it is.

It’s interesting to do other researches to examine if this trend, of decreased emphasis on employee involvement, is also observed in other business activities, considering the methods of production management surveyed over the past decades and cited in this paper, and others which might be identified.

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