IMPLEMENTATION OF 5S METHODOLOGY IN A METALWORKING COMPANY

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Abstract: *Nowadays, flexibility is of the utmost importance in organizations in order to respond quickly to customer requests. The implementation of Lean tools requires a major transformation in the company's culture; on the other hand, it also generates enormous advantages and enables great adaptability. 5S is the foundation of Lean production systems. This is not merely a method of cleaning the work area; it also includes methods for sorting, organizing, cleaning and standardizing. This paper reflects the work carried out in a metalworking company. This basically involved analyzing all the problems observed in a machining cell in order to provide solutions. This was essentially undertaken through 5S methodology, but the process was also improved by resorting to other necessary tools and actions such as layout changes. This project aimed to improve the cell itself, making it a safer place to work. The tools implemented in the production cell have improved safety in the workstation, increased productivity and drastically reduced waste.*

Key words: *Continuous Improvement, Lean Production, 5S Methodology, Manufacturing Industry*

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1. Introduction

Over the last two decades, the market has been subjected to continuous change and has become increasingly competitive. During the course of the manufacturing process, companies have sought to improve quality, flexibility and delivery response time to customers by adopting the principles of Lean thinking (Rosemary et al. 2014). While this term has been widely acknowledged over the last years and in the most diverse areas, the underlying principle has always been the same: maximize the customer’s value and generate the least waste possible (Melton 2005, Mudhafar et al. 2017). Even though the Lean concept allows companies to develop and improve their market position, they usually experience difficulties in changing and adapting to it (Magdalena & Beata 2017). The use and implementation of Lean tools demand a great change in the company’s culture and strategy, which is usually counter-intuitive to people’s habits (Maia et al. 2011). One of these Lean tools is 5S methodology, which started in Japan and was first developed by Hiroyuki Hirano in the 80s. It includes five Japanese words (Patel & Thakkar 2014): Seiri (Sort), Seiton (Set in order), Seiso (Shine), Seiketsu (Standardize) and Shitsuke (Sustain).

The work described in this article was developed at the company Manitowoc Crane Group Portugal (MCG). Its main goal was to implement 5S methodology in a machine cell used in the welding process of cranes with a view to making the workstation more efficient and safer. The article is divided into five sections: section 1 consists of an introduction to the work at hand; section 2 presents a review of literature pertaining to 5S methodology; section 3 describes the methodology used to carry out this study; section 4 presents all the practical work developed at the company, firstly dealing with the cell in question, and subsequently, with the problems detected and the improvements implemented in the process; lastly, section 5 provides the conclusions of the work developed.

2. Literature Review

5S methodology constitutes the basis for the implementation of any improvement activity. It consists of a visual cleaning technique which presupposes a compliance with five activities in order to create a workstation which will be suitable for visual control and Lean practices (Melton 2005). The method allows for the improvement of the system’s performance since it helps to reduce the time required to add value; this, in turn, enables an increase in productivity and enhances product quality (Omogbai & Salonitis 2017). 5S is the acronym of five Japanese words (Mariano et al. 2015) which represent the five stages inherent to this methodology:

- 1S – Seiri (Sort): The objective is to classify all the unnecessary items and segregate those which are not useful on a daily basis (Filip & Marascu-Klein 2015).
- 2S – Seiton (Straighten): The principle is that defining a location for all goods within the work area, so that these are always stored in the same place (Ramdass 2015).

- 3S – Seiso (Shine): This implies cleaning the entire area and equipment so that the best hygiene and safety conditions prevail in the workstation (Filip & Marascu-Klein 2015).
- 4S – Seiketsu (Standardize): Standardization constitutes the first step in maintaining the first 3Ss implemented. The objective is to create standard procedures throughout the operation, so that operators can always perform their daily tasks in the same manner (HungLin 2011).
- 5S – Shitsuke (Sustain): The first three phases are operational; the fourth maintains the state reached through the previous phases, and the fifth phase fosters a commitment to continuous improvement (Mariano et al. 2015).

The 5S program promotes many important benefits for the organization. The most noteworthy of these are: the maximization of efficiency; the reduction of defects; better safety in the workstation and an improvement in the worker’s life quality and morale (HungLin 2011). Countless scientific articles have presented cases where 5S methodology was implemented and produced extremely positive results. In the small-scale manufacturing industry, various authors have demonstrated that, at different intervention intervals, this practice generates several benefits such as: better space management; increase in productivity; reduction in the time required to find objects; prevention of tool loss (Ashraf et al. 2017); less waste; improvements in the work environment (Devkar & Raut 2016), in safety and productivity, as well as efficiency and cleanliness. Besides these, the system also promotes strong work ethics, since there is a greater commitment by operators to maintain good practices (Agrahari et al. 2015).

Other companies in varied industry sectors such as the areas of textiles, technology, automotive and metallurgy have also embraced this methodology. In these cases, the results have allowed one to conclude that there are improvements in cleanliness, environmental performance, health, safety (Rahman et al. 2010) and response to the customer (HungLin 2011). It has also been proved that this methodology can be sustained if the operators’ motivation is assured (Patil et al. 2016). Nevertheless, the advantages derived from 5S implementation are not restricted to the manufacturing industry alone. On analyzing the interventions undertaken in the most diverse service industries, one can state that the ensuing improvements were clearly noticeable. A university laboratory promoted better organization and was thus able to improve safety, reduce the time wasted on object-seeking, as well as enhance the environment and workflow (Mallick et al. 2013).

Another laboratory, in the pharmaceutical area, was also able to reduce costs and increase free space (Mariano et al. 2015). In health care facilities across various worldwide hospital sectors, improvements were observed in parameters such as safety, efficiency and patient centralization. If the low costs of implementation are added, it can be concluded that this practice should always be the starting point for any attempt at quality improvement in the health sector (Kanamori et al. 2016). It has thus been demonstrated that, regardless of the type of work undertaken, performance is undoubtedly improved through 5S practices (Ghodrati & Zulkifli 2013).

However, despite the fact that the methodology supports a company's objective to achieve better performance and productivity, results have also pointed out some concerns. The most significant of these lies on the lack of communication and cooperation by senior management, which constitutes a huge hurdle and can only be addressed through continuous training (Ghodrati & Zulkifli 2012).

3. Methodology

The methodology used to carry out this work consisted of several stages. In the first stage, one studied the entire productive process by means of data collection from the factory floor and by consulting MCG's internal documentation. The second phase consisted of undertaking a review of literature related to analysis methods and tools, as well as the improvement of productive processes. This was supported by scientific articles, theses and books pertaining to 5S methodology. The purpose here was to sustain the empirical investigation presented in a coherent manner. In the next stage, the third, one proceeded with the mapping of the problems detected and of all the proposed improvement measures. It was during this phase that one also drafted a plan of the work to be done and gathered all the required documentation. The final phase consisted of the improvements implementation with a view to eliminating the problems found and refining the productive process.

4. Implementation of 5S Methodology in a Machining Cell

This cell comprises two pieces of work equipment which carry out the machining process, and are known as Caser (see Figure 1). The process consists of mechanically cutting/roughing parts in order to obtain surfaces, holes, vertexes or edges, which are extremely accurate in measurement and are superficially coated with a high quality finish.

Fig. 1. Machining cell

4.1 Identification of Problems

Before *in situ* work was initiated, the team met for brief training during which one presented an explanation of the principles to be implemented. After this training session, the team visited and provided a critical analysis of the machining cell in order to prepare a course of action for the activity. Table 1 presents the problems identified in the work cell, as well as the respective solutions proposed.

Problems Identified	Solutions	Stage of 5S Methodology
Unnecessary or obsolete tools	Application of the RED TAG method (identification card)	1S
Inadequate support facilities	Correction of support facilities	2S
Inappropriate workbenches	Improvement of benches	2S
Rather disorganized cell	Development of a new layout	2S
Tools scattered across the workspace	Creation of a Tool Shadowboard (board for hanging up tools)	2S
Worn-out floor surface	Placement of floor markings	2S
Individual protection equipment (IPE) hanging on the workbench	Provision of lockers for IPE	2S
Disorder of auxiliary tools	Provision of a tool trolley	2S
Unidentified oil deposits	Identification of oil deposits	2S
Work and support facilities do not comply with the colour standard	Execution of painting in accordance with the MCG standard	2S
Cement floor (absorbs liquids)	Painting of the pavement surface	2S
No cleaning material in the cell	Provision of a Cleaning Shadowboard	3S
No cell cleaning routines	Creation of a 5S Area Board (to hold documents)	3S

Tab. 1. Identification of the problems and the respective solutions proposals for the machining cell.

4.2 Stages in 5S Methodology

The 5S *in situ* implementation was carried out by means of a Kaizen activity. A multidisciplinary team was established, which purpose was to implement the first 3Ss on the machining tool, at the most reduced cost and time, and respecting the 5S concept. The first rule is “step-by-step” implementation, namely never proceeding to the following “S” without meeting all of the previous “S” requirements.

4.2.1 The 1S Stage (Simplification)

Many of the tools in the machine cell were found to be obsolete, damaged or simply useless for the work to be undertaken. Besides these tools, the workbenches and cupboards were also unsuitable for the work being done (see Figures 2A and 2B). The classification and separation of material, tools and unnecessary support items allowed for an increase in free space in the cell, thus making the workstation tidier and safer. In addition, the fact that only the really necessary items are now found in the area, reduces both confusion and time spent looking for the required tools.

All of the tools which were not essential for daily work were identified by means of RED TAG identification (see Figure 2C).

Fig. 2. [A] Inadequate workbench; [B] Excessive number of cupboards; [C] RED TAG.

4.2.2 The 2S Stage (Organization)

This phase began with the reutilization of all the existing structures in the machining cell so that the support facilities were renovated and made more useful for the operators using them, thus minimizing expenses.

The new workbench is far more efficient and the creation of a Shadowboard enables operators not to waste time looking for the tools and lifting accessories (see Figures 3A, 3B and 3C).


Fig. 3. [A] Previous workbench; [B] New workbench; [C] Shadowboard.

The auxiliary Caser cutting tools were mixed up and disorganized (see Figure 4A), which caused workers to spend too much time looking for tools; in the case of new operators, this also often led to the choice of the wrong tools. In addition, the storage method constituted a safety risk, and handling caused sometimes cuts to the hands.

Changes were made to the trolley in order to organize tools according to size, identifying and positioning them vertically (see Figure 4B). In addition to this trolley, one was able to transform one of the unused cupboards and built another, which is more ergonomic, safer, more practical and mobile, thus ensuring a place for each tool (Figure 4C).

These improvements enable both the elimination of error as well as greater speed in the choice of the correct tool. The fact that these are now positioned vertically/diagonally makes the work safer and allows the handling of tools to be more ergonomic and less tiring.

Fig. 4. [A] and [B] Before and after the tool trolley; [C] New tool trolley.

Other adaptations were carried out, such as the division of a cupboard into small individual compartments, similar to lockers, where operators can keep their IPE (Individual Protective Equipment) and not leave it scattered around the work area as before. Another example was the adjustment of a structure, which was initially used to store the Caser cutting tool when this was not in use. Wheels and a safety device were added to the structure so that it could be used both for storage, as well as for the transportation of tools; thus, operators will no longer have to wait for the overhead crane, which can take up to 15 minutes. This task therefore became faster, more practical and safer. In the oils section, none of the products was identified. This invariably led to time being spent in the singling out of identification labels, which were very often illegible. With regard to the lifting accessories, all of these were scattered on top of the oil collection or deposit tanks (see figure 5A). These situations were solved by adding identification labels to all the oils (see figure 5B) and by building a shadowboard. One thus reduced both the chances of making mistakes and also enabled an increase in task execution speed (figure 5C).

Fig. 5. [A] Untidiness on the oil tanks; [B] Identification of tanks; [C] Shadowboard for container lifting accessories.

The final task consisted of developing a new layout and placing all the floor markings. Due to these changes (see figure 6A), the distances covered by operators when carrying out everyday tasks were reduced; the transport of materials also became smoother and more efficient. All of the work and support structures were painted in accordance with the Manitowoc Colour Standard, and the floor pavement surface was painted in grey to reduce the absorption of oils and facilitate cleaning by operators. In addition, risk areas were identified by means of safety markings (see figure 6B).

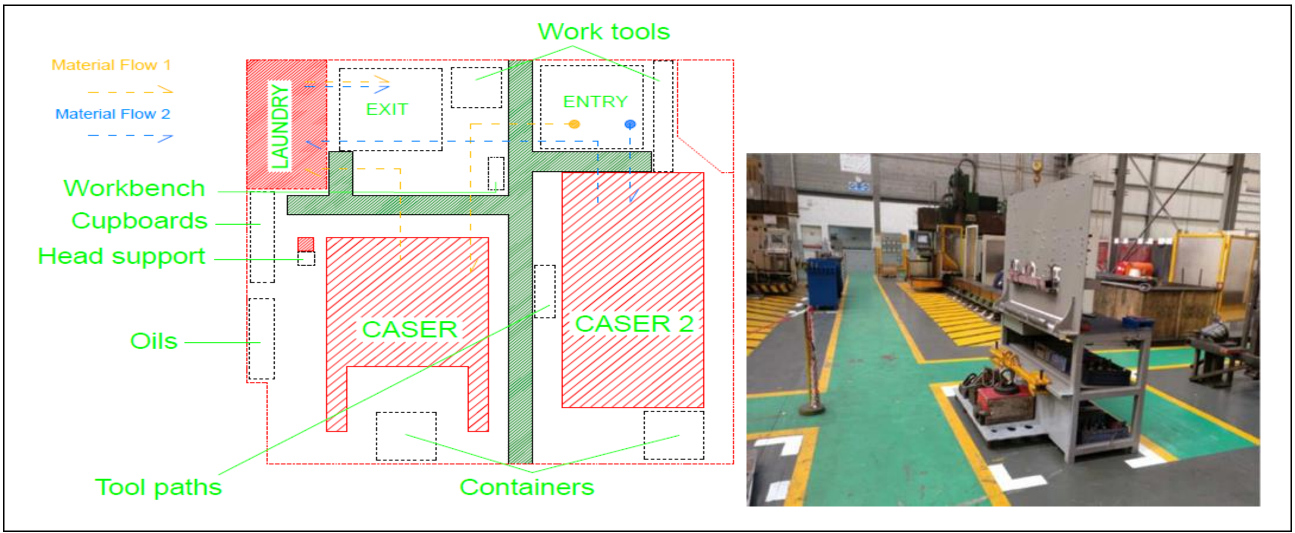

Fig. 6. [A] New layout; [B] Marking of structures and of the safety areas.

4.2.3 The 3S Stage (Cleaning)

The machining cell looked rather disorganized and dirty. Besides generating a large quantity of filings due to the cutting of pieces, the operation itself discharges a substantial amount of oil onto the area surrounding the machine, which results from the lubrication required.

This not only causes a negative impression but also makes the cell dangerous for operators. Consequently, and in addition to the Checklist of basic daily tasks presented in the 5S table applied to the cell (see figure 7A), one built a shadowboard during this stage; this is where all the tools required for this routine cleaning procedure are now stored (see figure 7B).

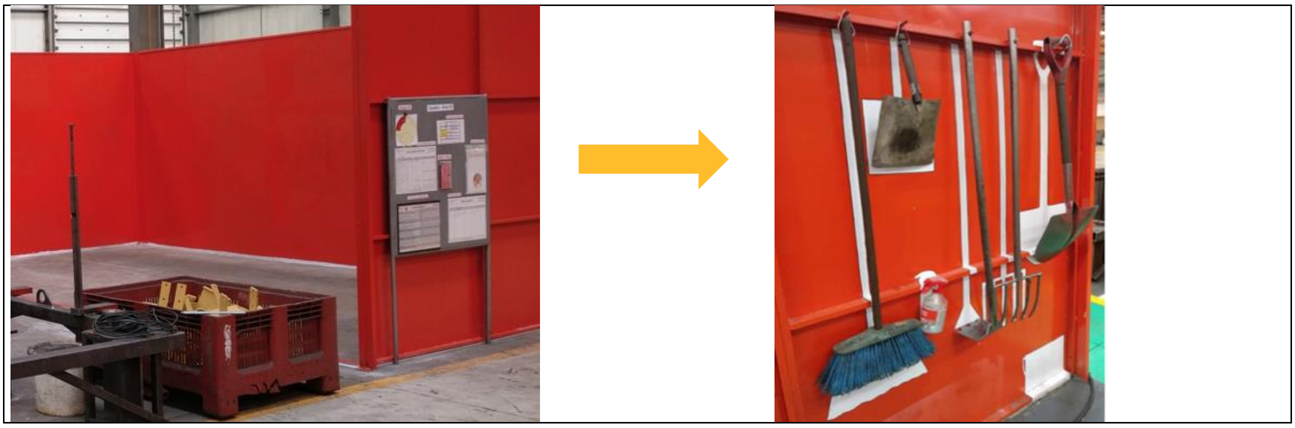

Fig. 7. [A] 5S Area Board; [B] Cleaning shadowboard.

4.2.4 The 4S Stage (Standardization)

In order to maintain the first 3Ss, access must be ensured to document support: this presents all the procedures and principles to follow, and sets out the routines which are to be fully implemented in the operators' professional practice. This consists of three very important parts (see Table 2).

Documentation	Descripton
Visible on the 5S Table	• 5S Wheel • List of RED TAG objects • Blank RED TAGs (to be filled in) • Audit Forms • Plan of Actions
Document Support	• 5S Procedure • RED TAG Flowchart • Definition of Standard Colours • Standard Procedure for Identification • Instructions for the completion of the 5S Wheel
Established Routines	• RED TAG Activity – to foster a mindset in which the operator will ask himself whether the whole tools available at the workstation are necessary. • Shadowboards – Storage for support tools and cleaning utensils on standardized toolboards. • Cleaning Checklist - The operator has a checklist to provide information as to what must be used, where and when, in order to keep his workstation clean and tidy.

Tab. 2. Essential features of standardization.

4.2.5. The 5S Stage (Sustain)

In association to the routines created, visual tools and documents will not, in themselves, sustain 5S. Although they provide great assistance, it is the operator who must incorporate some of the fundamental values involved, such as: self-discipline, politeness, respect, commitment, pride and the sense of a job well done. Indeed, when operators working at a specific workstation participate actively in a Kaizen activity, this automatically gives them added responsibility since they now participate in all the decisions made by the team.

They will subsequently have the responsibility of maintaining their workstations in line with the 5Ss implemented. The 5S audits also constitute an important part in this process and take place monthly, in all of the 5S Areas. By providing an assessment which relates to the 5S Wheel (see figure 7A), these audits show how the next “S” can be reached by using the action plan.

4.3. Results Analysis

An analysis of the work undertaken has enabled one to visualize some of the potential aspects of 5S methodology. This technique has allowed for the simple solution of problems, without great investments, but which have produced an extremely positive impact. By implementing the proposals, one was able to achieve the results described in Table 3.

5S Stage	Analysis of Results
1S	• More free space in the cell - elimination of unnecessary items; • Improved use of the workstation – greater speed in finding objects; • Less chance of losing tools.
2S	• Workbench is more ergonomic and safer; • Fewer mistakes in the selection of Caser auxiliary tools; • Greater speed and safety in tool use; • Handling of tools is less tiring for the operator; • Better storage – more space to keep tools and IPE; • Greater autonomy (reduction of waiting time); • Improved layout organization; • Less distance covered by operators and materials; • Waste material, labour and time reduced to the minimum.
3S	• Greater cleaning efficiency – organized tools; • Easier verification – checklist with routines; • Safer cell – elimination of accident sources; • Better visual aspect; • Improvement of the work environment.
4S and 5S	• Improved company standards; • Improvement of internal communication; • Improvement in human relations (closer ties between senior management and the shop floor workers); • Increase in workers' pride and morale; • Increase in productivity.

Tab. 3. Results achieved.

5. Discussion and Conclusions

The work presented has produced remarkable gains, both in the production area as well as in those of quality and safety. Owing to the nature of the improvements undertaken, most of which were organizational and visual, it is difficult to measure the results obtained in an accurate manner. This is a limitation of this work.

However, by observing the work carried out, one was able to perceive that when the cleaning and organization processes are increasingly executed, the operators' performance and productivity are also enhanced. This is a direct consequence of workers being able to find everything faster, without making mistakes, in a more ergonomic and safer manner, thus executing their tasks more effectively. The result of these changes is reflected in minimum levels of waste material, as well as in reduced labour and times which, in turn, lead to a greater reliability of delivery dates and, ultimately, customer satisfaction.

However, the advantages are not merely restricted to the visual aspects and to the mathematics of productive efficiency. Through these improvements, one also observed higher levels of morale and pride in the workers. There was, furthermore, a visible improvement in the work environment and in internal communication/human relations. The existence of more room, better storage organization, as well as several other changes, all contributed to making the workstations safer by limiting the chances of accidents. It is undeniable that all of these aspects are essential to everyone's sense of wellbeing. There is great relevance in highlighting that these parameters are of great importance in a philosophy of continuous improvement: only by having motivated staff can one possibly hope to achieve positive results. One must also highlight the importance of promoting training activities to discuss these Lean techniques with operators; this is fundamental to the process since workers are, unquestionably, the drivers of change.

It is also expected that in the future, through discipline and a compliance with the proceedings for the 4S and 5S stages, the company will achieve a greater capacity to criticize and organize, so that the cells will not return to their previous state of neglect.

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