



CONTRIBUTIONS REGARDING THE IMPLEMENTATION OF LEAN MANUFACTURING AND SIX SIGMA TECHNIQUES IN THE METALLURGICAL INDUSTRY

Anda Crangureanu¹, Dan Eremia¹, Dan Nitoi², Oana Chivu², Marius Teodorescu³

¹Prysmian Group, Str. Draganesti nr. 28, Slatina, 230119, Romania

²Politehnica University Bucharest, Splaiul Independentei no. 313, sect. 6. Bucharest, Romania

³SC Teo Consult Auto 2003 SRL, Campia Libertatii, no. 37 A. 0219836

Corresponding author: Nitoi Dan, nitoidan@yahoo.com

Abstract: Lean Manufacturing is a production philosophy that determines the reduction of the time from the customer's order to the shipment of the product, by eliminating losses. 6s is a method to organize and manage a workspace or a workflow and aims to improve efficiency and quality by eliminating waste, improving workflow and eliminating useless processes/activities. Predictable, organized and safe workplace. The method is based on the 5S methodology and has been empowered by including "Safety" as one of the pillars. The presented research referred to the improvements brought by the implementation of the 6 sigma concept in a processing section by wire drawing of different sizes. the article presents the six steps followed in order to implement the concept: 1s: sorting; 2s: ordering; 3s: cleaning; 4s: standardization. In the last part of the article, the audits that take place in the wire drawing section and their results are presented and the ways in which non-conformities are treated.

Key words: wire, drawing, 6 sigma, audit, improvement

1. INTRODUCTION

Wire drawing is a process of cold plastic deformation of metals and alloys to obtain wires, by forcing the metal material through a calibrated hole whose section is smaller than the section of the initial material. The surface of the aluminum and copper wires must be smooth, without: oxidation spots, grooves, scratches, cracks, chips, scales, bulges, twists, and excess oil. In the case of the wire drawing section, the raw material is brought from the raw material warehouse, located in the immediate vicinity of the wire drawing area, with the help of the overhead crane.

The wire is placed on the unroller of each trefoil. From the unwinder, the wire is passed through the range of dies, depending on the desired final diameter. After this operation, the dies are mounted in the die holder support. From the final die, the wire is passed to the wire accumulator and from there to the double winder. The drawing of the aluminum wire is done starting from the diameters indicated above. The wires obtained from the heavy drawing process constitute a finished product for electrotechnical purposes or by-products used in the construction of other types of insulated or non-insulated electrical conductors. The pulling force is calculated with the formula:

$$F = C \cdot \sigma_m \cdot (S_0 - S_1) \quad (1)$$

where: σ_m is the average resistance to deformation (daN/mm²); C - the coefficient that takes into account the friction against the die; S_0, S_1 - wire section before and after drawing. Treating can be of two types:

-heavy wire drawing in which the wire can be: round aluminum wire, ϕ 9, 12, 15, 20, 25 mm (heavy aluminum wire drawing); round copper wire, ϕ 8.0 mm (heavy copper wire); easy wire drawing; Al wire obtained from the heavy drawing process with a maximum diameter of ϕ 4.5 mm. (light aluminum drawing); cu wire with ϕ 2.5 mm (light copper drawing).

2. IMPLEMENTATION OF 6S IN THE ENERGY-METALLURGY WIRE DRAWING SHOP

In a wire drawing shop, compliance with quality standards, development and implementation of quality measurement and evaluation methods are essential to face the special competition in this field. Lean Manufacturing is currently the most important management method for manufacturing companies. The method is used in conjunction with the quality tool called "6 sigma", based on the Toyota production system and is adapted by Womack and Jones, in 1995, for Western companies, referring to real basic capabilities. Applying Lean Manufacturing provides exceptional results without the need for complicated systems, so it is a suitable method for SMEs with limited resources. Lean Manufacturing means flexible cells or assembly lines, more complex jobs, highly skilled workers, well-made products, a much greater variety of interchangeable parts, necessarily excellent quality, reduced costs by improving the production process, international markets and global competition.

2.1. Presentation of 5S

The 5S process is a structured program to systematically achieve: organization, cleanliness and standardization in the workplace. The content of the 6S and the benefits brought by their application is as follows:

1. Seiri - Sorting = Organization
2. Seiton - Stabilization of order = Order
3. Seiso - Shine = Cleanliness
4. Seiketsu- Standardization = Standardized cleaning
5. Shitsuke - Sustaining change = Discipline
6. Safety = The only way for advancement

The application of 6S in a company whose activity is obtaining wires of different diameters by wire drawing can be summarized in Figure 1.

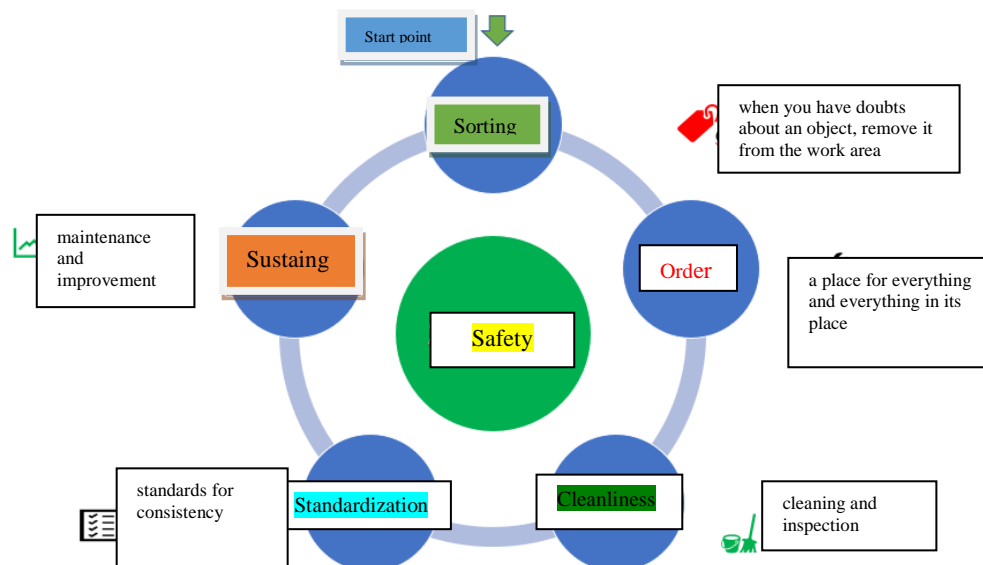


Fig. 1. The application of 6 S in a company whose activity is obtaining wires of different diameters by wire drawing

To successfully introduce 6S in the workplace, the application of each "S" must be understood by every employee and must be practiced regularly. Training material was created and presented for Prysmian employees with the help of Training by the person responsible for the 6S implementation. The most important tool in 6S is dividing the unit into small areas (functions/processes) and then introducing the methodology step by step, area by area. The order of implementation differs from factory to factory depending on their specific needs.

The main responsibilities that must be taken into account for the application of this work philosophy are:

- identification of facilitators for 6S in each area; training on methodology and tools; performing/coordinating monthly audits; ensuring that operators are involved in decision-making and execution of actions; transferring the vision to all stakeholders; the support of the 6S area facilitators in the implementation of the 6S methodology and tools; coordination of 6S facilitators through knowledge sharing to ensure uniformity of application and ease of implementation; development and implementation of action plans for each area and their coordination; developing and supporting a communication channel with all interested parties; continuous improvement of the performance of the 6S management system.

2.2.1. 1S – Sorting

The first step of the 6S process refers to the identification of all the elements that exist in a well-defined work space, establishing their usefulness within the work processes, separating the work tools that are usually used from those that are not used, freeing the space by removing all unnecessary materials and objects (eg files, programs, test pieces, drawings, old or defective instruments, accessories, unused materials, etc.). The objectives of this stage are:

- reducing the loss of time in searching for an object by reducing the number of items.
- reducing the chances of being distracted by unnecessary objects.
- simplification of checks.
- increasing the available and useful space.
- increasing safety by removing obstacles.

Figure 2 shows the actions taken in this regard in a wire drawing factory.

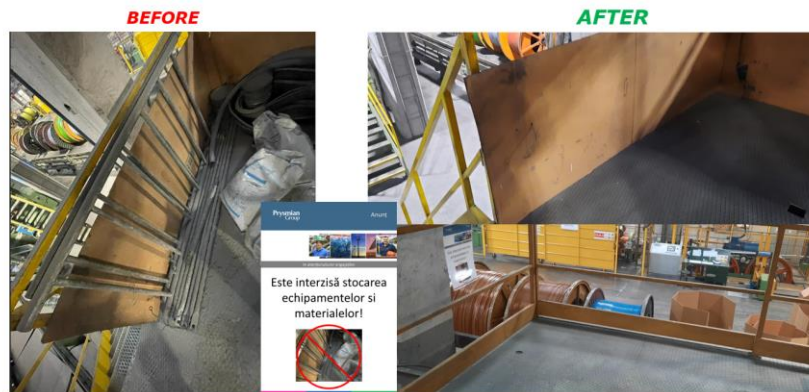


Fig. 2. Application 1S – Sorting

2.2.2 2S - Order

The second step of the process is about sorting and organizing all objects, equipment, files, data, materials and resources for quick and easy access to them. All tools or equipment required for a job or process should be stored in a predetermined location and in a logical order to facilitate their use, to be easily accessed or brought back to the same place as quickly as possible. Fixed locations must be established, such as boxes, containers, shelves, cabinets with transparent doors, panels, markings on the floor for access ways, containers for all the usual materials and tools, their storage being done according to the frequency of their use. If all staff have quick access to any item or material, work flow becomes more efficient and, as a result, staff becomes more productive. Labeling must cover all storage spaces, tools and equipment. Figure 3 shows an example from this stage.



Fig. 3. Application of 2S – Ordering

2.2.3. 3S - Cleanliness

The third step of the 5S process is to clean the workplace (floors, machines, cabinets, desks, etc.) so well that it "sparkles". Shine requires that all objects and equipment in the work space are kept clean and in proper working order. This is the easiest to understand and yet most often overlooked step in 5S implementation. Keeping things

clean and in working order go hand in hand, this will eliminate interruptions, repairs and keep the production flow constant. New standards must be set for cleanliness. All trash, grease and dirt must be cleaned and removed. Everything should be clean, tidy and well placed in the right place. Cleanliness provides a safe workplace and makes potential problems immediately visible. Figure 4 shows an example of the application of this step.

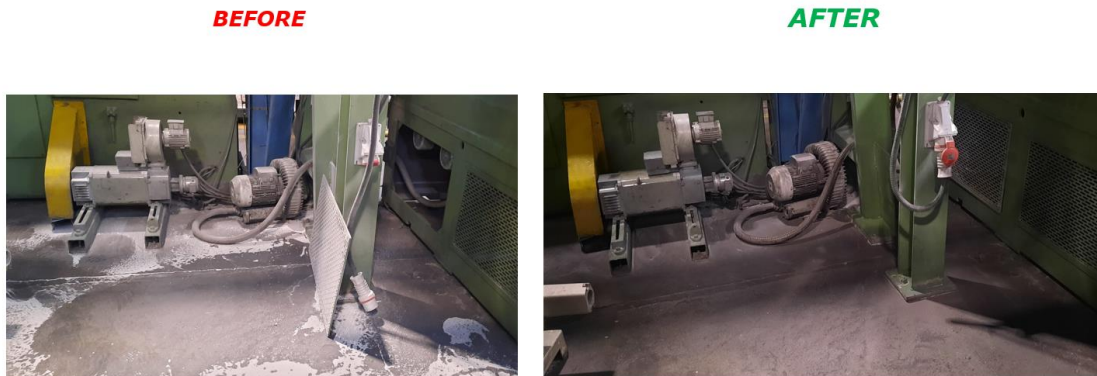


Fig. 4. 3S – Cleanliness

2.2.4. 4S - Standardization

The fourth step of the 6S process consists in defining the standards (rules, customs and standard procedures) to which the staff must refer in measuring and maintaining the optimal degree of order and cleanliness. Thus, the creation of a routine for carrying out tasks can ensure that every time things are done correctly and efficiently. When performing a certain type of task several times, it is good to identify the most efficient way to complete that task and create a standard. Production often has different processes on different shifts. This means that at least two of the shifts perform the work in a less than optimal way. Standardizing processes helps avoid mistakes and improve efficiency. From this stage, Figure 5 a shows - the marking and storage of equipment, and Figure 5 b - the marking of raw materials.

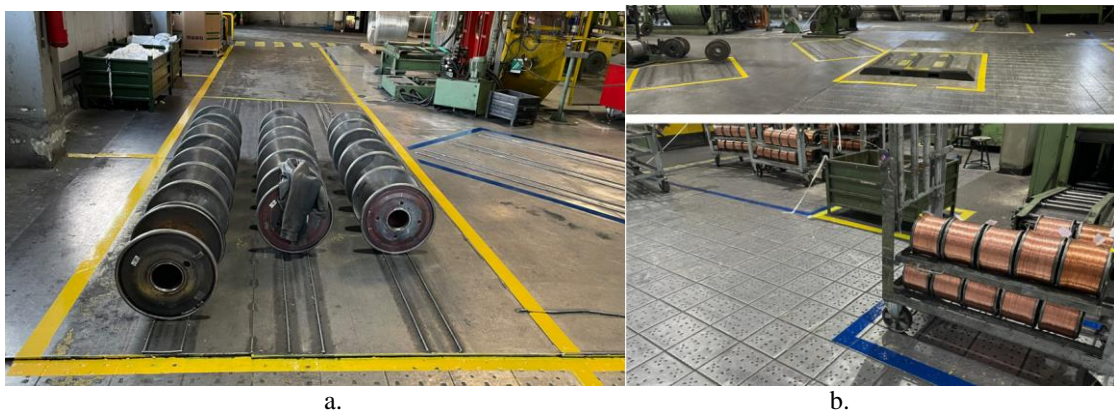


Fig. 5. 4S application - equipment storage marking; b - raw material marking

2.2.5. 5S – Support

Sustaining also means the effort to develop a culture that follows the steps of 5S both now and in the future. For this, make the 5S system part of your culture and incorporate it into the company philosophy. 5S must become one of the organizational values so that everyone thinks in 5S. Integrate the 5S methodology into the performance management system.

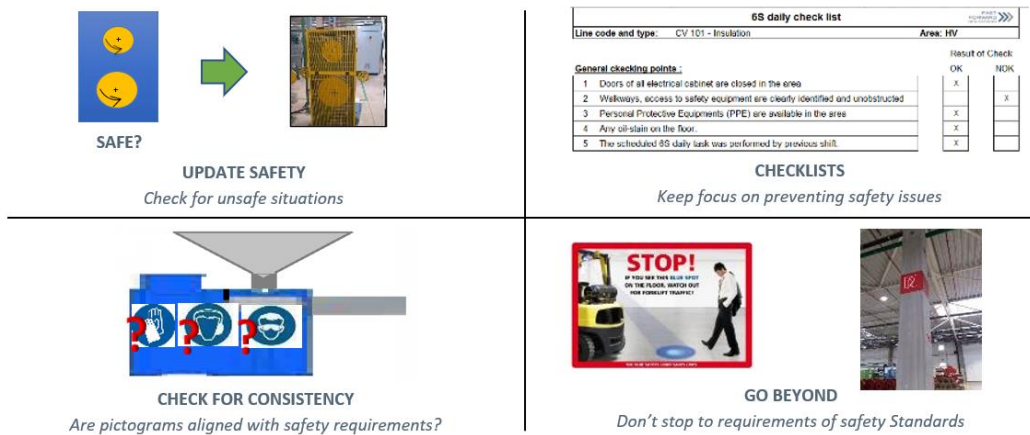
Objectives:

- Ensuring that the 5S approach is followed.
- The foundation of the support is the elimination of bad habits and the generalization of good practices in the work environment - on a technical and technological level, but especially on a social, ethical and moral level.

2.2.6. 6S - Safety

The safety of the operators, of each employee, but also of the user depends on the application of the previously discussed 5s. Safety is the result of organized work, everyone's attention to non-conformities and risks and their

reporting. Awareness and tracking of this step is done through several elements, some of which are shown in figure 6.



“Turn your attention to accident prevention”

Fig. 6. Implementation of safety at the workplace

For successful implementation you must:

- create a safety mindset to exceed safety requirements;
- follow up daily on the points above, not only when the audit takes place;
- be proactive in highlighting potential safety concerns - involve the local HSE team;
- cooperate closely with maintenance to drive safety actions with the highest priority;
- visit the Yammer -Good PracticeGroup to find solutions to improve safety;
- use monthly audits to check the status of active protection devices;
- communicate safety KPIs (GI, Accident Free Days, etc.).

Figure 7 shows examples of the application of the 6S methodology in the Energy factory.



Fig. 7. Application example of 6 S

3. CONCLUSIONS

The paper presents the successful application of the Lean Manufacturing production philosophy through the implementation of the 6S in a company in the field of wire production. Here are some examples of the application of each step, which highlight the situations before the application of the concept and the situations after the application of this concept. By applying Lean Manufacturing, or production at minimum costs, the aim is to reduce the time from the customer's order to the shipment of the product, by eliminating losses. The implementation of LEAN principles has become a survival strategy in a production environment where cost

reduction represents a state of fact on the market that can no longer be avoided by any industrial economic operator.

4. REFERENCES

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