STANDARDIZATION IN PRODUCTION – THE EXPERIENCE IN AN AUTOMOBILIST FACTORY

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Abstract. *The standardization consist the instrument to configure the production line and assure the repeated operations in the work stations in almost all fabrication process. The principal objective is to structure, at first time, the process and in the second moment, to maintain him and develop the excellent quality level during the work journey. The metodologie applied is an exploratory reseach and was completely realized in an automotive company. The standardization is also the formalization of the work routine established at one productive work unit. In spite of the established conditions, this process isn't always sufficient robust to assure the very good work conditions because sometimes any element can not be considered or not be correctly evaluated. In these cases it is necessary to realyse an audit to evaluate the quality level and the standardization of each work station. In addition to the specifications, and to well define an operation, it is also necessary to consider the analyses of mouvements that operators realize. All these points are presented in the first part of chapter 2 in which a bibliographic review were realized. A detailed description of each steps to be followed is well described(in a Operational Procedure) and this will permit also to elaborate the document called balancing line in which is possible to specify the sequence of work to be realized for each work station. A brief description is presented to determine the principal benefits and importance of standardization, to complete the bibliographic review. In the sequence, it is presented the methodology to define how to do a standardization at a work unit as well as the application in a practical case, object of this study. And, at the end of this part of the article it will be present two figures that permits to do a comparison between them. It will realize the analysis about quantity of work stations standardized against the amount of detected defects in the process. Through the comparison between Figure 01 and Figure 02, it is possible to identify the defects elimination that were previously observed. A brief discussion and conclusion, concerning the method and the situations that had happened during the standardization of the work stations is also presented. Considering the obtained results it is possible to say that the standardization really can eliminate the problems observed in a process. But to perpetuate this method is of fundamental importance that the supervisor maintain his daily routine of checking to assure the quality of the standardized process. s.*

Keywords*: standardization, quality, ergonomic and process control*

1. INTRODUCTION

The requirements that costumers do about quality against the organizations has been the subject of various discussions and sometimes even judicial process. Thinking on that, and principally in a way to maintain the costumer, many companies do heavy investments in quality programs, especially ISO 9.000. Based on these programs, the methodology of standardization gains its force to be consolidated in the business as indispensable quality tool.

To establishes uniform methods, practices, process, engineering or technical specifications is used a standard. A standard consists of a reference document used to establish criteria to be followed during the execution of an activity, tasks or service. It is usually designed by an organization that is responsible for the creation, establishment and dissemination. Some institutions of repute may be cited as the ISO - International Organization for Standardization (2009) and DIN - Deutsches Institut für Normung (2009). The standards (for Quality, Environment, Safety and Ergonomics) set by these institutes will be used by companies that make the standardization in their production processes or services.

The standardization in an industry is an activity of long duration, because it involves many factors, like adequate training to use the methodology, constant operator analyses in work stations and the obligation of the supervisor to do each work station and write the procedures.

2. THE STANDARDIZATION IN PRODUCTION PROCESS

Many companies, despite their follow daily routines of work, do not have formalized their procedures. Probably these companies did not identify this need, or the results obtained so far are considered good, even before the occurrence of adversity in certain moments of production.

The standardization was the key vehicle for the consolidation of the Japanese quality movement. It has focused on the uniformity and orientation of common knowledge pool. From the viewpoint of a Japanese expert in quality, "The standardization consist the systematic accumulation of knowledge in which the technology has been based."(GARVIN, 2002).

The emphasis is related to analysis of causes and not only more attention to the effects. This is the effort that Paladini (2000) comments to add quality to the production process.

The standard work is the foundation for the creation of a repeatable process that consistently produces the desired result. The standard work is also the foundation of training. It is impossible to train a person until it knows how to work, and it is impossible to improve an unstable process that each operator performs in a different way. Any improvement becomes in a more different way to do the work (LIKER, 2009).

The standardization of the production process represents the elaboration of formalized routines in function of the activities realized at a work unit. It`s necessary to consider also the work organization, that concerns to the quality, the production and the productivities, the security and the workers health.

According to Huge and Anderson (1993), the cost of poor quality includes internal failures as tailings and rework and failures as expenditure on external security, inspection and detection of failures and prevents them.

Campos (1998) affirms: The standardization is the base of the Quality Structure. It can be developed in the organization by the creation of Quality Culture by the methodology known as Five Senses (5S) or Housekeeping. Since that implementation is done, the organization will be able to start the process of standardization, eliminate the anomalies and manager the organization.

According to Moura (1999), when the standardization is applied, the organization presents a strong competitive advantage trough the implementation of the culture of “To do right at the first time.” It is a hard task to obtain good results and it will be necessary a lot of energy and personal discipline to achieve this concept, but it is really possible.

As mentioned by Oliveira *et al* (2004) for competitive advantage, the organization is forced to find ways to teach men, who are part of it, to generate information and knowledge. It now exists in the organization the knowledge formalization from a wider dynamic to act, an organization must have the knowledge.

Marshall *et al* (2003) comments: One of the greatest successes of mass production, characterized by Ford's development of assembly line and scientific management of production, was the standardization of parts and components. The adoption of a management system requires, normally, the standardization of methods and practices of an organization, and a good way to start the standardization of an enterprise may be the implementation of ISO 9000 series standards.

The standardization must be realized in the condition that all operations developed by the operators in the production line need to be formalized. All of them must be written in a way to assure the established procedure and no possibility to occur any anomaly during the work journey. Even to the different work shift, the procedure to realize the operations must be the same and also all observations defined in the procedures need to be followed. When a process is specified, it means that all operations are defined in the best form to be realized until that moment. But, considering the constant development, it can be changed if it is necessary, principally when a word called kaizen, is used frequently.

In addition to the specifications, and to well define an operation, it is necessary to consider the analyses of movements that the operators realize. This simple rule will assure that the operator will not execute a bad movement, so he will not cause any restriction and damage to himself. Example, if the anthropometric profile is not well defined and identified at the begin of the project, probably this worker will have some pain in his back or in his arms when he will execute operations repeatedly. As consequence of this definition, the operator will force his arms and the result will be his restriction of the work place.

Part of the work includes a standardized rating of the main points of safety in the descriptions of work. The standardized work describes, in order, the steps to accomplish it at the appropriate time, in addition to the most appropriate members’ moves. Operations Procedures includes details on how to perform the work correctly, and often in detail, presented by images, including the correct angle and height to position a tool so that, for example, the pulse is not in an unsafe position (LIKER, 2009).

To minimize rightly the exposition of one unique operator at the work place during a period of eight hours continue, the fabrication unit realize three exchanges of operators at the work place in a predefined periods. This situation will permit at least three operators well trained to realize the operations in the work line during a journey of eight hours. And, another situation identified to reduce the operators fatigue is like that: The operator that starts the work at a hard work place considered critic (according to ergonomics specification), in the second period he will work in a place that is not as hard as the first one. This work condition will permit to him to do a good performance and to recuperate his energy during the daily journey.

When subjects related to standardization and ergonomic are available in process fabrication many conditions must be considered, and sometimes they are very specifically. The supervisors and other people that will work with these subjects have to have a specific training about these points, because they will use it directly in their work. To well evaluate the standardization versus the ergonomic situations, this article will also present a comparative between them in order to define the positives and the negatives benefits of the standardizations in a process, obtained during the actors experience in the standardization implementation.

The standardization is also important to allow for critical analysis and the consequent improvement of procedures and methods of the company, it offers a concrete perspective of that review and improve. (Marshall *et al*, 2003).

2.1. The Benefits and the Importance of Standardization

The standardization of an activity and/or a process demand time and people training. To realize the standardization of a structured and consistent form, the following documents need to be elaborated and applied: Engineering Folder, Operational Specifications (also called POP, in Portuguese), Balancing Line Document and Operational Training Folder. These documents are considered the principal base of standardization and must to be specified in the Quality Management System of the organization.

According to describe by Curi Filho (1999), there are many benefits that standardization offer, among them may be cited:

- Qualitative benefits, that respect the proper use of equipment, raw materials and the workforce; assists in the training and improvement of technical level of the workforce, also records the knowledge acquired of employees;
- To operate the process the standardization ensures the control of products and processes, in addition to the safety of personnel and equipment. Contributes significantly to the streamlining of processes, and broad source of continuous improvement.
- Benefits provide quantitative reduction of consumption and waste of materials. It also promotes the standardization of components and equipment, reducing the products variety, increases productivity and improves quality of products and service.

According to IZI-QUALIDADE (2009), in addition to the benefits and also in order to well identified the importance of standardization in the quality management, below are listed some important characteristics:

- Without a stable basis, i.e. without the provision of a standardized process it is not possible to make improvements, because you cannot improve what is not known or which varies constantly. How to know the current level of performance if there is no result, some other different, better or worse than the previous? The standard creates a foundation on which other techniques can be applied more elaborate, like benchmarking, the "reengineering", the "outsourcing", the "kaizen", among others.
- Another role of standardization is the delegation of routine tasks. With the stability of the processes it is possible to delegate the conduct of cases to the people who operate the freeing management to worry about the projects that aim to improve more competitiveness to the company.
- The standardization is also the basis for operational training. Having defined the procedures become easier and easier to develop in people the skills and knowledge necessary to perform the tasks. And the tasks according to the standards ensure the maintenance of the results.
- The standardization is not limited to the establishment (consensus, drafting, approval and distribution) of the standard, but also includes their use (training and verification of its continued observation). This means that the standardization only ends when the execution of work as the standard is ensured.

2.2 Description of the Standardization Process

The standardization should be done so that all operations carried out by operators in the production line is drawn, and should be described to ensure that no anomaly occurs in the day to day. Even to work different shifts, the procedure for carrying out activities to observe what has been defined by standardization. When standardizes a process means that all operations is the best way to be held until that time. However, it should be subject to constant improvement in order to promote the growth of operational skills, the methods and ergonomic and in some cases to promote the improvement / optimization of equipment in the industry.

Usually the documents/specifications of the product being manufactured have its origin in the Department of Engineering. With some exceptions, the client has its own design / specification for the manufacture of their product. In Engineering Folders the specifications are defined to be obeyed for the product to be manufactured as expected during production operations. Among some examples can be cited: the torque that a screw should receive in the process of assembly; the assembly sequence of a particular component; the type of glue to be used in an operation of gluing of components; the dimensions of a particular piece to be manufactured, among others. The use of a picture helps much in understanding and allows a good view of a particular specification or operation to be performed. In the Engineering Folder still must be specified the same number, the name which the transaction relates, a table showing the latest revisions made (with the number of developments that occurred, the name of the person who made the change or created the document a brief description of this review and the date of making the same). Specific characteristics should also be specified in Engineering Folder. Comments are made here about the security features and / or regulations, which must be prioritized and implemented as advocates provided in legislation.

Based on information provided by the Department of Engineering, the Department of Manufacturing Engineering Folder uses to describe the operations to be performed according to established specifications. It is important that all

activities related to standardization are properly recorded. The supervisor of the production line, in possession of this document is to establish the POP function, specifying in detail the operations to be performed, because he is the person who best knows the conditions and / or existing constraints in production, including the provision parts in production line, the ergonomic conditions of employment, among others. Within this article the systematic specification of activities to be carried out (how) is the responsibility of the Department of Manufacturing. It is good to remember that the description of the operations by this department can vary from plant to plant.

2.3 Description of the Operational Procedures Preparation

For the description of the operational procedure preparation is possible, the production supervisor must perform the operation in the work station to be standardized and then analyze and write the operations in detail. This is done so that the supervisor can identify any difficulties that may exist in the conduct of an activity and transcribe it as best as possible for the analysis of the operation. To well describe the operation, the supervisor uses the following questions: What to do? What part of the body used to make the transaction? What object? How?. Example: Take the right hand with a pneumatic screwdriver located in front, holding it by the cable and the thumb positioned next to the button to trigger the pneumatic screwdriver. The description of each transaction must occur in detail for the entire sequence of carrying out the task. In addition, also, to defining an operation, it must also consider all the movements of the operator, as it performs an activity, may provide restrictions on anthropometric profile or weight. Therefore, the POP describes how to do what was specified by the Engineering Folder so that anyone can perform the operation after reading this document. This way of specifying a transaction has as its main objective the incidence of non-occurrence of problems or questions by the operator upon completion of the activity in question. Still on the analysis of the operation, it should be considered, where applicable, the use of equipment and methods specified.

Performed only after a detailed analysis of the operation it is possible to set the name of the main stage, which is a summary description of the operation to be performed. To facilitate the definition of a major step, it suggested the following question: Do what where?. E.g.: Mount the water tank in the engine compartment.

Besides the analysis of the transaction, in the POP (operational procedure) are set the main stages, the key points and reasons of the key points for operations that may be generating potential defect, or who requires critical attention by the operator, or that have caused problems in times past. Thus it is possible to prepare a document setting out the steps to be followed for performing an activity with precision. For operations that may affect the quality, safety or the security of compliance with specific function and / or regulations, it established a key point, which is the essential element of a major step and that is for the operator to look for this detail the realization of it. An example of a key point that can be applied here is the noise or click that a piece makes when it is mounted in a hole. The operator will know that he performed the operation after have hearing the noise or the click of the piece when mounted in the hole. In the field reason of key point, explanatory design, operatory rules and other, located beside of the key point, it should explain the reasons for choosing the key point. For example, after examining the operation it was defined that the main stage would be the "tightness in the trunk" the reason for the key point was "Because water can not be identified inside the trunk." A single transaction can contain a maximum of three key points, and all must provide a reason for which was specified. Other information's the supervisor judge necessary may also be included here.

The use of a tool and / or device must also be described in the POP, when applicable, and follows the same methodology used for describing the operation to be performed. Operations for possible adjustments of the pressure gauges may also be part of operational procedure. The description can be performed followed by a drawing to illustrate how to use the tool. The suggestion to do a drawing instead of a picture, is due to the fact that the first is more specific, while a picture may present much more information than is necessary and this may causes confusion for the operator, when reading the POP.

At the bottom of the operational procedure form are two important information's: What is forbidden and why? (Explanation of any problems or defects), and How to deal with anomalies (items or notes / Others). Are two fields that can be used by a manufacturing supervisor at the completion of the form or in daily maintaining.

The operations description in the POP should be numbered. This allows separate, for example, activities that are performed on the right or left side of the vehicle. It should not be very long, so that no problems occur in the interpretation or excess of information in the same operation. The very extensive operations must be divided to facilitate the reading and interpretation of the activity to be performed by the operator. At the end of each analysis, operations should be separate by a line or dash.

Another important detail to consider when drafting the analysis of the operation is to define the time of completion of the transaction. This information will be of great value when the production supervisor will prepare the document for Line Balancing (document that is used to define all the activities and the sequence of them to be performed in a work station). The time of conducting each operation needs to be timed and then recorded in POP. By definition, the unit of measurement of time to be timed should be considered as CMIN (cent-minutes).

To finalize the development of POP, the fields related in to the header of the document must be completed. It is made reference to the type of vehicle manufacture, name of factory where the operations are done, internal work unit of each department, number of Engineering Folder (from where these operations have been specified) and sequential

numbering of the POPs, e.g. : Page 1/2, which is the POP 1 of 2 prepared under the same number of Engineering Folder. It must be filled the fields Name of Procedure or operation, individual protective equipment to be used in conducting this operation, possible tools to use and possible parts to be mounted on the vehicle. The time needed for learning by the operator is also important to consider, as well as possible licenses and/or qualifications that are necessary for the realization of their activity.

In the conclusion of POP development, it is necessary to make the sum of all times specified in this document and it must fill the field of Total Time from all Steps. In the development of POP, the column N is used to inform which date this document was created and then it is sent for validation of the production boss and their supervisors of the plant (when there is more than one).

Thus, with the POP elaboration, the supervisor or the team leader has broad conditions:

- Train operators in the workplace, following a unique procedure;
- Provide details of operations, without any errors;
- Assess whether a transaction is or is not well done;
- Capitalize the best work method during the operation standardization;
- Evaluate the performance of your work unit through graphics control, considering the quality dimensions: Cost, Time, Quality, Safety and HR.

3. PRACTICA CASE – IMPLEMENTATION OF NEW STANDARD IN AN AUTOMOBILE INDUSTRY

The introduction of this new working method in an automobile industry was a heavy activity, especially for the supervisor, because in addition to routine activities of their responsibility for monitoring the indicators of production, he also had a responsibility to realize the operations in the work stations and then describe them on the basis of information available in the Engineering Folders. The issue of the supervisor to perform production activities in the work stations was a very important step with regard to greater knowledge ownership of operations at its unit of responsibility.

The technical support provided by trained personnel in the implementation of this methodology was important to address the questions that arose during the preparation and description of the Engineering Folders and POP's.

Applying this methodology in the manufacturing process means that more activities are carried out in the best possible way. Especially with regard to operational sequence, that is systematically repeated for each operation. All operators with a license to work in the work station have to carry out the same operation the same type of vehicle in production. It can be said therefore that the repetition of operations is very close to perfection.

To ensure that this is actually accomplished, there are some ways to monitor the operations. The first can be said is that when defining the procedure in a work station, a person is appointed by the controller to be part of that position, called owner of the work station. From this moment, this person is responsible for the proper definition or sequence of operations in the post of responsibility, together with the supervisor of production. Thus, it was possible to involve and compromise the operational level for issues related to good standardization of unit of work.

The training that exists for new entrants is always accompanied by the holder of the work station. How is the holder of the work station that helps the supervisor in preparing the POPs, is he who makes the training of new operators for the post of his responsibility. This is a good practice which was identified to have a higher motivation among the operators and especially to be stimulated to continuous improvement in the production process. From the time that the holder of the work station reviews the methods of the person that is in training, he can also identify possible points of improvement and contribute their comments on an action plan for evaluation.

Another situation in which it evaluates the performance of activities on work stations is related to the Operational Training Sheet. Here are the names of all operators of the work unit and the level of knowledge of each for each work station. For example, if the operator does not know the work station in the field related to it there is no marking. Whether he is in training, the field is filled with an exclamation mark. From the moment he is trained on the job, or from the time he can perform all operations without the aid of the post holder, to ensure the operational sequence, in the cycle time of the job and without the occurrence of any defects, he will be able to conduct the work station. So, in his situation the Operational Training Sheet is modified to indicate I. Usually the training carried out for a job has duration of one week.

In addition, the situations presented above, an audit conducted by the supervisor, also called Line Audit, evaluates each work station, according to a schedule defined by him. This audit is realized to verify the issues related to the methods put forward the work station documentation (POP), the level of operational training, ergonomic conditions and whether there are quality problems associated with the post. Several issues are raised in the time that the operator is doing the activities during the audit. The post in question is evaluated on ergonomics and possible points of improvement. The operator being audited has the opportunity to suggest any improvement in their job. Finally, the supervisor evaluates the situation of the work station and especially the operational issue, defining if it is OK or if there is a need for intervention.

Applying these check methods is possible to keep a good level of standardization of the process. In addition to already explained above, the internal audit is also considered a good way to measure the extent that the work stations can promote in quality

Failures in the standardization of work stations may occur. However, if followed the steps specified above, the possibility to occur it will become very small. But situations may happen that were not initially foreseen in the Engineering Folders and/or POP's. In this way, the POP is considered a living document and it is possible to add any additional information to it in order to make the process more robust.

4. DISCUSSION

The transition phase between a work system to a more detailed procedure have its proper time of matured. In the case of a systematic work that contributed to a radical change in the way of activities realization, it caused an enormous initial impact in the organization activities especially as regards them on the work unit.

The greatest difficulty faced initially was related to how to translate the words to get the majority of gestures and movements made by operators during the conduct of operations. As the methodology was presented in an innovative way, there were many doubts about the inclusion of terms and definitions commonly used in the production line. However, the focus of development of POP was mainly in the description of how to do what was specified by Engineering. Through the use of draws could minimize the detail in terms of local operations and operational gestures, which greatly facilitated the transcription of operations.

The major operational difficulties observed with the deployment of the new methodology were in breaking the existing paradigms hitherto existing. The previous operational sequence performed was not standardized among the operators themselves, which favored the omission of a transaction with the generation of a defect.

As a result, it was not possible to assign responsibility to people for its activities and mainly because the supervisor also did not have completely knowledge of operations realized in the work unit. The training conducted by the job was not standardized, which allowed an operator to be trained in a different way. One point that was considered as the essence of standardization achieved in the jobs was the definition of a person holding a job. This facilitated a lot the information spreading and they started to become more involved and engaged with the activities to be undertaken.

At the time of deployment of this methodology, the company had activities in two work shifts. As shown previously, there was a standard procedure, but not too much robust and this was directly reflected in the quality indicator as a result of the work unit. The incidence of problems was reasonable and was not possible to identify the real cause of it. With the implementation of this methodology, all operators perform the same operational sequence and this contributes significantly to the problems elimination. An exceptional gain when compared to the situation before. Here are two graphs that correspond to the total number of defects identified during the period of eleven months in 2005, for the work stations of Units 1 and 2, in which the methodology on standardization was implemented. It is possible to observe in Figure 1 the quantity of work station, per unit per month, which was standardized, following the methodology presented here.

In Figure 2 it is observed that the amount of defects which were generated in Unit 1 provides reduction from the month of February, months that began the process of standardization in this article. In the period February-April six work stations from a total of 11 were standardized. The remaining work stations of this unit were standardized in the months of May and June, and the result obtained from this month was the elimination of defects generated in the same month.

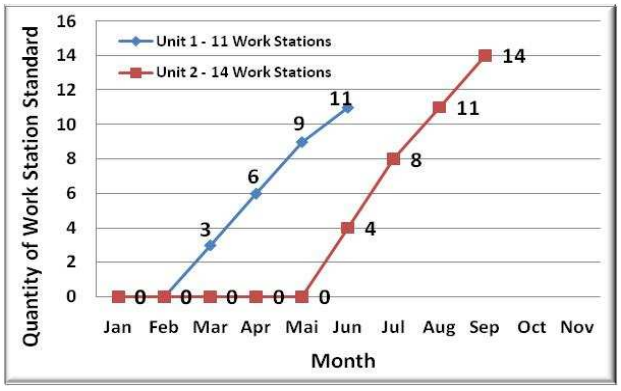

Figure 1. Quantity of Standard Work Stations

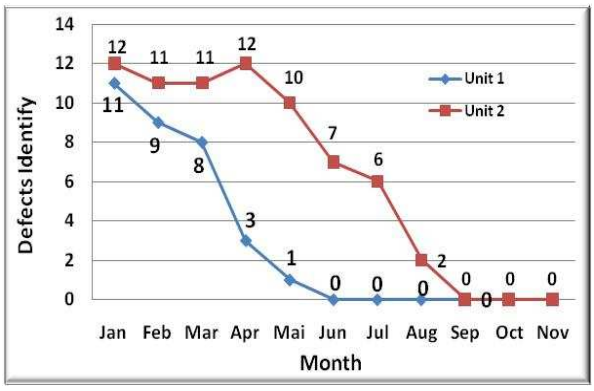

Figure 2. Quantity of Month Defects Identified

For Unit 2, the first results on the monthly defects reduction were obtained only after the beginning of standardization of work stations, which occurred since June, in which 4 work stations, from 14, were already standardized. Observe that the total number of defects also decreased with the increase of work station standard in Unit 2, reaching the mark of zero defects generated in the unit from September, when 100% of the work stations, in this unit, were standardized.

5. CONCLUSION

By implementing this standardization method was possible to identify a process where there is no clear definition of activities to be undertaken, it is doomed to failure. The incidence of problems is great and resolution is not carried out to eliminate the root cause of the problem. In this case, the probability of a defect repeat is very large and that certainly will erodes the image of the company before the client and hence a reduction in revenues of the company.

Detail the operations to its essence leads to a thorough analysis of the whole process. The identification of errors is encouraged, and also provides the development and enhancement of creative thinking and intellectual people.

Rather than establish a standardization in the production process, the introduction of this new methodology has contributed significantly to explain the concept of quality in production process. The definition of a holder to establish the work station action was a decisive commitment on the part of each operator and primarily responsible for each one that is necessary to define a unique procedure. This has contributed significantly to the continuous quality improvement. And several times observed in the production line that failure of the procedure, caused a defect.

Empowering people is essential because it is through them that the improvement opportunities arise and these are people who perform or implement changes suggested in their jobs. Committed and involved people produce more and better and these points were well identified in this deployment.

The proposal drawn up by this article was to share practical experience, observed on the daily deployment process of standardization in work stations. A brief description of specific points of procedure, such as establishing a key point of an operation, balise and structure them to ensure that the product is manufactured entirely appropriate according to specifications recommended.

The function of quality control is no longer an exclusive responsibility of the Quality Department and becomes a responsibility of the supervisor of production, because it is the manager and responsible for ensuring the application of standardization in their work unit. This fact is evidenced in two very specific situations. 1) Is the responsibility of the supervisor to establish the writing standard, i.e. the relevant documentation to the work station and ensure that what is written is the best way to implement that activity until that moment. 2) Is the responsibility of the supervisor, also conduct an audit in work stations, in which he evaluates, among other things, the operational sequence, formulates questions to the operator about the knowledge of the information in the POP, the possible non-conformities generated by this same work station. And, issues suggestions and reviews on ergonomic are also evaluated on this time.

The results obtained with the standardization in units 1 and 2 showed that after implementation there was significant reduction in the amount of defects. The standardization is considered, and therefore a technical activity that has great positive influence on the correct conduct of one or more methods, leading them to excellence.

All these actions made in the basis of "ownership" and "to want to do it right the first time", provide exceptional levels of quality, both in the work unit as in the manufactured product. Also contribute significantly to the rates maintenance and patterns obtained for continuous improvement in the work unit. Thus the institution appropriates knowledge in a best structured form, which until that moment did not exist, and provides clear and objective evidence that it provides and stimulates continuous improvement within the organization in its day to day.

The methodology presented in this article was originally implemented in the units 1 and 2, and subsequently spread to other units of the department.

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7. RESPONSIBILITY NOTICE

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