Abstract: - This paper focuses on the World Class Manufacturing, an innovation program based on Continuous Improvement, that provides the elimination of all types of waste and loss of production through the involvement of all levels and all departments. In this work is defined a model based on the logical opening of the different pillars that make up the World Class Manufacturing in the Light version, and the definition of appropriate performance indicators that can give a view of the involvement, the management effectiveness and the achievement of objectives. The Case Study focuses on the implementation of two pillars in particular, Cost Deployment that acts as a guide for the implementation of the program and Workplace Organization.

Key-Words: - World Class Manufacturing, Workplace Organization, Cost Deployment, Lean management

1 Introduction
The present work is focused on the World Class Manufacturing, an innovation program based on Continuous Improvement, that provides the elimination of all types of waste and loss of production through the involvement of all levels and all departments. The main purpose is to be successful on the market with high quality products at competitive prices, responding to the customer needs, ensuring maximum flexibility. This is the main reason why the Italian Automotive Company has made it his workhorse and why it has decided to extend its suppliers. In the paper was analyzed the WCM methodology outlined in the WCM temple and developed in various pillars that compose it. In particular, we analyzed the pillars that make up the WCM Light package. The pillar of Cost Deployment represents the reporting and reduction of losses, the Workplace Organization represents the improvement of work stations within the establishment, the pillar of Safety concerns the safety of the plant with the goal of having zero accidents, the pillar of Quality Control to reduce major defects attacking the root cause, the Focused Improvement, which provides tools for setting improvement projects, the pillar of People Development, which aims at the involvement and training of human resources, the Logistics & Customer Service to improve the allocation of materials inside the plant and increase the level of customer service, the pillar of Autonomous and Professional Maintenance that address the reduction of failures of equipment and facilities. Then the aim of this work is the definition of a WCM implementation model, which can act as a guide for the implementation of this methodology within the supplier and that represents a succession of several pillars to open, starting from an analysis of the current state and following the compass of Cost Deployment.

Finally, we have analyzed a Case Study on the implementation of WCML in an important supplier Italian
Automotive Company, following the model defined before. The implementation of this methodology led to the activation of the pillar of Cost Deployment and Workplace Organization for the reduction of losses resulting from non-value added in the assembly process of the products supplied to the customer. The result of this implementation, doesn’t stop at only these two pillars, but it implies 56% losses reduction very evident at first sight, the improvements made by WCM and future development of this methodology is in this supplier Company.

2 The World Class Manufacturing

The recent crisis in the new economy did emerge clearly the importance of careful management both strategic and operational of the supply chain. It is therefore necessary to consider, in a more systematic approach, the strategic area of operations, rather than simply, the mere technical and operational aspects. In Lean Production the role of physical transformation is apparent and badly in terms of strategic planning. Primary factors of change at the origin of “Lean Revolution” and subsequent “World Class Revolution” can be identified in the following points:

- the progressive reduction of the product life cycle;
- the difficulty in reliably predict the demand for finished products, components and subassemblies;
- the resulting inability to calculate correctly the load input to the production system which intends to be irregular;
- an increasing mix of finished products demanded by the market, needed to satisfy an increasingly demanding;
- The increasing competition of the emerging country competitors that are difficult to win on the cost side, but also on quality.

So, we must rewrite the production process to answer the needs of global market.

The World Class Manufacturing (WCM) is an integrated system that brings the excellence of the entire logistics cycle and production of an undertaking by:

- Continuous improvement of all services;
- Involvement of all levels and functions;
- The adoption of the principles of Total Quality, Lean Production and the “Integrated Factory”.

The seven key factors for WCM success are:

1. Reduction of lead time;
2. Rapid response to market changes;
3. Cut the costs of operation;
4. Excel customer expectations;
5. Managing the global enterprise;
6. Manage processes in outsourcing;
7. Improving the visibility of the performance of your business.

3 The WCM methodology

From the operational point of view the WCM methodology is developed in the deepening of the ten major aspects of production, called Technical Pillars. These pillars are associated with ten Managerial pillars that apply to all work teams, management and workers, which are regarded as the true protagonists of the revolution basically Bottom-up.

In particular, the “Technical Pillars” are as follows: Safety, Cost Deployment, Focused Improvement, Quality Control, Workplace Organization, Professional Maintenance, Autonomous Maintenance, People Development, Logistics & Customer Service, Environment

The “Managerial Pillar” at the base of the technique, are as follows:

Management Commitment, Clarity of Objectives, Route Map of WCM, Allocation of Highly Qualified People, Commitment of Organization, Competence of Organization, Time and Budget, Level of Detail, Level of Expansion, Motivation of Operators

Each pillar has seven steps that must be covered and certified to implement this methodology, in the bond that you can’t go to the next step if you have not completed and certified the previous step. These columns address the business functions in their daily work and require an analysis of the benefit/cost which is the discriminating factor for the feasibility of that is about to undertake. Each project must be implemented to have a competent team, a cost analysis, actions to improve the benefit / cost ratio, and constant monitoring over time. The concepts of depth and breadth of the WCM are further innovations in the sense that this methodology requires that individuals holding a limited area on which we begin to do yard, and only when the team gave the expected results, and followed strictly the steps provided by the pillar you can think of the extension of the methodology, which consists of identifying other sites, which are areas identified as critical analysis of the preliminary costs. In practice, if this proves to be strict in a limited scope, it is unthinkable to go further and extend the process. The score that comes from formal audit establishes a competition between plants leading to a further push to the improvement.

4 The WCML implementation model

The manufacturing industry in general and the automotive industry in particular face of increasingly difficult challenges. The importance of a strategic plan and a partnership between the automakers and suppliers is becoming increasingly important as the auto industry goes global. In reality, the future presents an increasingly technological partnership with suppliers with a view to getting more competitive to achieve a leadership position in the market. The automotive Group with the World Class Manufacturing will lay the foundation for achieving this position facing different challenges in terms of logistics, in terms of the transport network and quality standardization. In all of this, the suppliers represent for the customer Company a key element of high strategic value for achieving this, since a company can greatly improve its processes, but if the materials that are provided are of poor quality, all of its products will be affected. In fact, the
World Class Manufacturing requires many suppliers who are World Class and may participate in the development of new products, and can always guarantee the same quality standards. The intensification of competition on quality and price, the high impact of supplies and the need to achieve a global presence in the market lead in developing new forms of collaboration. In particular, the WCM vendors are starting to get goals and to develop systematic approaches to improve and invest in their skills and manufacturing capacity. The manufacturer, however, must learn to manage these strategic partnerships by defining roles and adequate back-up information. The main objective of the car manufactures Group is to reduce substantially the number of suppliers, while increasing the quality of the products they provide. The reduction of these has several advantages for the company customer as it allows you to have more control over orders, to streamline the relationship between manufacturer and supplier of lowering prices and going to assign larger volumes. From the perspective of suppliers is essential, therefore, included in that group, with a view to obtaining new contracts and new business opportunities. The strategic value of WCM is that in order to come in this group of providers, you must implement this method to adjust the quality levels of supplies to the standard required by the customer.

The main problem of the implementation of WCM (also for WCM Light for suppliers) is the sequence of pillars to open, because there is not a standard of opening and activation of WCM pillars. So, there is the need to have a guideline for opening of WCML pillars and the following model is a way to answer this question. This model is called WCML Tree Model because the flow chart for the opening of pillars, is like a tree and this analogy is made to show the integration of all pillars that are expected by this methodology. At first we must analyse the current state for the implementation of WCM. An important indicator is the number of Lean techniques within the production system management, where technical means those families of instruments that form the basis of Lean Production, such as Value Stream Map, the Kanban, 5S. This index can be called Lean Presence Index LPI.

\[
LPI = \frac{N^0 \text{ Lean techniques in the system}}{(1)}
\]

Lean techniques have found the company, does not mean that the company is lean, because such techniques should be adopted and used in ordinary work by all employees. So in addition to the first indicator is useful to make another appointment that is the relationship between the number of Lean techniques adopted and the number of Lean techniques within the system of production management or the LPI. This relationship can be defined as a Lean Use Index LUI.

\[
LUI = \frac{(\text{number of techniques used})}{LPI} (2)
\]

If the index is greater than 50\%, should be easy to implement the proposed WCML Tree Model.

After this analysis, the first pillar of the new methodology to enable must be the Cost Deployment because that’s what makes a guide for the reduction and elimination of losses of a business. In addition, the Cost Deployment is a pillar which initially requires the participation of all major corporate resources (production, maintenance, logistics and quality), so it can be used to involve the different actors in the program and bring to the attention of the potential benefits that this methodology can bring.

In CD are defined the various losses and the macro-category they belong. For example, the loss of Non Value Added Activities, Balancing, lack of training are linked to Man macro-category, while failures and Minor-Stoppage, Set-up belong to Machine macro-category. The losses for non-supply lines, or defective raw materials belong to Materials macro-category. The loss of non-standard definition belong to Method macro-category. Identified losses, it starts the step of costing, and the allocation of the macro-category loss that has priorities. This priority is identified based on the amount of the loss of the main plant. For example, if the loss is the highest downtime, or the set-up, the macro-category that has priority is Machine. Based on this prioritization, and this link between macro-category and loss, it is therefore necessary to initiate activities of Workplace Organization for NVAA loss, or Autonomous and Professional Maintenance activities to reduce losses due to failures, Minor Stoppage or Set-up. For reducing Material losses is necessary to open Logistics & Customer Services pillar, and finally for losses related to the Method is necessary to open Focused Improvement pillar. In particular, the WO pillar attacks NVAA losses going to create standards, such as order and cleanliness, going to study Value Added for each location and going to shoot it down with appropriate countermeasures.

The AM and PM pillars attack the failures and minor stoppage losses, restoring basic conditions, eliminating the machines sources of dirt, creating cycles of inspection and maintenance that are functional to reduce the number of events that generate losses. Logistics & Customer Service, attacks all losses related to the materials with the aim of providing the right material to the locations, just in time, in the right quantities and with the right quality.

Finally, Focused Improvement provides key tools to reduce losses due to the method and non-standard setting. This pillar implements the various types of projects (Quick Kaizen, Kaizen, Standard, and Advanced Major Kaizen). Each is aimed at reducing losses through the tools of analysis and definition of the causes of problems or the 5W+1H, 4M and 5Why’s, in order to implement the countermeasures and engage the appropriate resources. This involvement requires the development and activation of People Development pillar, which aims to provide the resources and objectives to address any training gaps, as well as to inform all of WCM. In particular, is necessary to map the skills of workers according to 5 levels of knowledge to achieve the targeted training, to create the system of assessment and recognition of ideas for improvement and point to the involvement of resources.
throughout the plant. Obviously, all people must work safely, so it is necessary to open Safety pillar, that reduce the potential causes of accidents and avoid incidents that could compromise machines and operators. People Development and Safety pillars, are cross-pillars in the sense that it involves two key aspects of the plant, so they must be activated together in order to create a sort of fertile ground in which to develop and integrate the methodology in complete safety workers. Once attacked the main loss macro-category identified belonging to the first, it needs to define priorities for action for the other major categories of loss and attack them with the main pillar that reduces that loss, until the four major categories are concerned. Activated all pillars, will start Quality Control pillar that will resolve the main recurring defects detected by the QA Matrix, with specific projects of Quality Maintenance or Problem Solving, and ensure the customer a higher quality product. The flowchart of WCML implementation is shown in Figure 1.

Fig. 1. Flow Chart of WCML implementation

This logic implementation of the various pillars of the WCML can be shown in a flowchart that provides the WCML Tree Model shown in the following figure.

Fig. 2. The WCML Tree Model

In order to evaluate the goodness of a model, methodology and provide information on its implementation, it is useful to set out the indicators that can provide a clear view of the system in place and can provide the basis for making decisions as effective as possible. For the WCML Tree Model were defined three main indicators that go to measure the involvement of resources, effective management and achievement of objectives. As a reference timescale was considered the year (calendar or fiscal is no different in order to obtain information that is as meaningful as possible). The three indicators are:

1. **Involvement Index II**;
2. **Effectiveness Management Index EMI**;
3. **Target Achievement Index TAI**.

The **Involvement Index II** is used to monitor what has been transferred to the methodology within the plant based on the number of tips provided by the operators, thus giving feedback on activities. In particular, the involvement index is the ratio between the number of tag plus the number of safety tips plus the number of Quick Kaizen made and the number of players in the establishment.

\[
II = \frac{(n° \ tag + n° Safety Suggestion + n° Kaizen Quick)}{(n° operators)} \quad (3)
\]

The **Effectiveness Management Index EMI** provides a measure of the response to suggestions from the management and improvement opportunities that emerge from the application of the methodology. In fact, this index is the ratio between the number of closed projects and the number of projects opened this year and is therefore expressed in percentage terms.

\[
EMI = \frac{(n° of closed projects)}{(n° of opened projects)} \quad (4)
\]

The range of values for this index is between a minimum of 60% to a maximum of 100% of projects open and closed.

The **Target Achievement Index TAI** finally determines the effectiveness of projects closed in the sense that not only to be opened and closed projects, but these projects must be targeted to the reduction and elimination of losses. It is the ratio between the amount of demolished losses through the closed projects and the total losses in the C matrix of Cost Deployment.

\[
TAI = \frac{(demolished Losses)}{(total losses)} \quad (5)
\]

This index, expressed in percentage terms, provides guidance on the achievement of the reduction and consequent improvement of quality and acts as a control for the IEG as it provides appropriate guidance on whether the projects that start breaking down the losses. The choice of these indicators was dictated by the need to keep under control the main WCM aspects, which form the heart of the methodology, and the need to obtain an indirect measure of the size of strategic suppliers. One of these key aspects, is the involvement of operators, which is the basis of the methodology implementation. Moreover, this index allows to understand if it is increasing the implementation level of methodology within the single
supplier, and it is one of the key dimensions for the selection of strategic suppliers. The other key aspect is the reactivity of management to proposals and improvements opportunities, which have to be monitored to increase the commitment to the methodology in question, which is one of the dimensions that guide the selection of strategic suppliers. The final element is the goals to be targeted for reducing losses. This should guide the management to increase the level of implementation of the methodology, that is, as seen, another critical dimension of strategic suppliers selection. Thus, these indicators are to monitor key aspects of the methodology and should be to greatly influence the main dimensions that allow to be a strategic suppliers for the client.

4 Case study: WCML implementation in an automotive supplier

This automotive supplier Company is a global diversified technology and industrial leader serving customers in more than 150 countries serving these markets through three business units:
- Building Efficiency is a leading provider of equipment, controls and services for heating, ventilating, air-conditioning, refrigeration and security systems.
- Automotive Experience is a global leader in automotive seating, overhead systems, door and instrument panels, and interior electronics.
- Power Solutions is the global leader in lead-acid starter batteries, advanced lead-acid batteries for Start-Stop vehicles and Lithium-ion batteries for hybrid and electric vehicles.

This Automotive Supplier Plant is located in the industrial area of central Italy and its only customer is a big Italian Automotive Company. In this plant door panels for two different cars are made. The manufacturing system before WCML implementation was a specific Manufacturing System (Mfg System) including several instruments of Lean Production. There was Kanban, 5S, TPM, Visual Management and other like the instrument of WCML but those instruments and tools were organized in ten modules. In fact the current state index of WCML Tree Model are:
- LPI = 10 (like Lean Modules of the specific Mfg System)
- The value of the Lean Use Index is 60% because only six modules of this Mfg System are effectively implemented in this plant.

\[ LUI = \frac{6}{10} = 60\% \]

So with WCML will fully meet the requirements of the specific Mfg System.

We have applied Cost Deployment and the first loss is Non Value Added in Ultrasonic Welding and precisely in Sytrama 1 2 3. So we have opened a Model Area of Workplace Organization on Sytrama 2 to reduce these losses. We have applied the three steps of WO and in the first step we have made 5S and we have applied the Tags to see all anomalies. In the second Step we have reduce all dirt sources and we have reduce cleaning time. Than we have applied Visual Management for material and equipment with all advantages of this instrument. Following this, we have studied the ergonomics aspect of workplace and we have introduced some ergonomics trucks to reduce MURI. We have studied MURA, irregular movements and MUDA to reduce waste. The solution has been a lock on pallet to reduce the opening and closing of lock (destaco) for door panels adjustment and we have had a saving of 2 second on this operation. We have trained the operators with One Point Lesson and Standard Operative Procedure and then, we have standardized all these things. In addition, in the third Step of WO, we have reduced the operation of assembly of one person for shift, in order to have another saving. The results of this application have shown in the WCML Tree Model Index, in fact the values of these at May 31 are:
- Involvement Index \[ = \frac{87 + 103 + 39}{126} = 1,82 \]
- Target Achievement Index \[ = \frac{11,640 + 45000}{100000} = 56\% \]
- Effectiveness Management Index \[ = \frac{34}{70} = 49\% \]

TAI is shown in the following Figure 3 and it is represented by the yellow area.

Fig. 3. Target Achievement Index

Instead, the Involvement Index trend for this case study is shown in Figure 4:
Finally, the Effectiveness Management Index trend for this case study is shown in Figure 5:

![Effectiveness Management Index](image)

**4.1 Results analysis**

These results show that 56% of its value, with a growing involvement in model area, although it should increase the management effectiveness and the closure of projects in order to be more reactive in the management. So it is important to increase the commitment on WCM because the value of 49% for EMI is low respect to the minimum value of 60%. The management must press to activate new projects and communicate that WCM is important for the continuous improvement of all parts of plant. Also, it is important to increase Involvement Index in order to have always involvement in model area and report anomaly, improvements opportunities and safety suggestions. In this way we will able to improve the implementation level of WCM and achieve an high value of this strategic dimension. For TAI, instead, there is not yet an elimination of the NVAA loss, so we must open other projects to eliminate this kind of loss and involve other people in the methodology after a new release of CD that will show the improvements of the application of methodology and will give a feedback about the importance and the effectiveness of WCM. The implementation level of WCML in this supplier Company is shown in the following Figure 6 like green areas of WCML Tree Model.

![Implementation Level of WCML](image)

**5. Conclusions**

The methodology of the World Class Manufacturing is not a simple set of tools must be arbitrarily applied within the company to reduce waste and losses, but it is a true business management system that complements, if not substitute, in all business practices. In fact it is as if the various pillars of technical methodology were going to replace the various business entities, thus becoming a reference for the development of this program. It can highlighting that at the top of the pillars there is a Safety that is something that in traditional Lean systems is not considered, but that represents a veritable anthill of costs and losses for the company, so the focus is concentrated on goal of zero accidents is to safeguard the human resources in order to avoid burdensome costs. As for this automotive supplier experience such as pilot plant of Central Italy in testing this methodology will certainly be one that will provide guidance in future of WCM, and this Company will be the one that mainly contribute to create the framework to support such a system to meet customer expectations with the customer and achieve World Class standards.

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