

# Application of Lean Manufacturing in a Ductile Iron Casting Facility

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## Background

ACP Manufacturing, LLC, a wholly owned subsidiary of Hitachi Metals America, is a ductile iron foundry located in the Northern Tier of Pennsylvania. ACP is a unionized foundry specializing in safety critical suspension components for the automotive industry. ACP has chosen “Lean Manufacturing” to address the increasing demands of the automotive industry to continuously improve in Safety, Quality, Delivery, and Price. ACP’s Lean Journey began in 2000 with the introduction of Total Productive Maintenance (TPM) to the shop floor environment. In 2004 ACP ramped up its Lean Manufacturing efforts with a more comprehensive program modeled after the Toyota Production System (TPS). Toyota is widely recognized for manufacturing excellence and TPS seemed like a good model for ACP because of the market served. The cornerstones of the Toyota Production System are Continuous Improvement and Employee Involvement and Empowerment.

This paper will discuss ACP Manufacturing’s Lean Journey including the application of the tools associated with TPS such as SMED, Kaizen and TPM. Knowledge and execution of the tools of Lean Manufacturing are important to the success of the organization, but the underlying philosophy of Lean is just as if not more important. In the book, *The Toyota Way* written by Jeffery Liker, the philosophy behind the system is discussed. These guiding principles can never be attained as a goal but provide the guidance which a system of continuous improvement can be initiated and sustained. ACP is attempting to apply this philosophy to its methods for conducting business. The Toyota philosophy is summarized by fourteen Principles divided into four sections;

### Section I - Long Term Philosophy

*Principle 1* Base your Management decisions on a long-term philosophy, even at the expense of short-term goals.

### Section II - The Right Process Will Produce the Right Results

*Principle 2* - Create a continuous process flow to bring problems to the surface.

*Principle 3* – Use pull systems to avoid overproduction.

*Principle 4* – Level out the workload (Heijunka – Work like the tortoise not the hare).

*Principle 5* – Build a culture of stopping to fix production problems to get quality right the first time.

*Principle 6* – Standardized tasks and processes are the foundation for continuous improvement and employee empowerment.

*Principle 7* - Use Visual Control so no problems are hidden.

*Principle 8* - Use only reliable, thoroughly tested technology that serves your people and processes.

### Section III - Add Value to the Organization by Developing People

*Principle 9* - Grow leaders who thoroughly understand the work, live the philosophy, and teach it to others.

*Principle 10* – Develop exceptional people who follow your company’s philosophy.

*Principle 11* – Respect your extended network of partners and suppliers by challenging them and helping them improve.

#### **Section IV - Continuously Solving Root Problems Drives Organizational Learning**

*Principle 12* – Go and see it for yourself to thoroughly understand the situation (genchi genbutsu).

*Principle 13* – Make decisions slowly by consensus, thoroughly considering all options and implement decisions rapidly.

*Principle 14* – Become a learning organization through relentless reflection (Hansei) and continuous improvement (Kaizen)

Like all worthwhile endeavors, the above principles are much easier discussed than implemented. The above principles also point out that Lean Manufacturing is a journey that requires a culture dedicated to continuous improvement. Without that culture change, any gains made will be short lived.

#### **Getting Started**

TPM (Total Productive Maintenance) was introduced to the ACP workforce in 2000 by a consulting firm specializing in that field. TPM is a comprehensive program to maximize equipment availability in which production operators are trained to perform routine maintenance tasks on a regular basis, while maintenance technicians handle more specialized tasks. TPM was extremely successful in driving improvements in uptime and throughput for all areas of the plant. TPM Teams were established for Melt, Mold, Core, Finishing, and NDT. Participation in the TPM Program was on a voluntary basis.

In addition to TPM, ACP had many initiatives in place to drive continuous improvement such as an employee suggestion box. Teams were in place to reduce scrap, improve yield, and reduce inventory by improving product flow. The teams were primarily made up of engineers and managers. With the exception of TPM there was little participation in those initiatives by the employee on the shop floor.

In 2004, ACP management recognized that a more comprehensive system was needed to sustain gains and develop a culture of continuous improvement that would be embraced by all employees. In order to kick-start its “Lean” journey, ACP contracted with a local manufacturing consulting group. NEPIRC (Northeast Pennsylvania Industrial Resource Center) is a government based organization chartered to develop manufacturing companies in the geographic area. NEPIRC was used for training services as well as providing direction to management. NEPIRC was utilized for one calendar year. Each employee was given a four hour “Lean 101” class. The consultant was used to guide the steering committee through a Value Stream Mapping exercise and to assist the team in the planning process. The consultant was used for training on the specific tools of Lean including Kaizen, SMED (Single Minute Exchange of Dies), Visual Factory, Process Mapping, and Poke Yoke (mistake proofing). After much debate, ACP shamelessly named its Lean initiative ACP PS (ACP Production System). A Logo was created and the slogan “Achieving Casting Perfection” was launched.



## Hearing Voices

In Lean Manufacturing, there are four voices that every organization must listen to in order to formulate strategy for implementation. Those voices are; voice of the customer, voice of the organization, voice of the employee, and the voice of the process. Some of these voices are intuitive to good management teams while others are less obvious and require techniques to reveal them.

*Voices of the Customer* – Customers in any business endeavor require Quality, Delivery, Service and Low Price in varying degrees of preference. ACP used the House of Quality technique to assess our customer’s needs and ACP’s performance in relation to the four areas above.

*Voice of the Process* – ACP utilized the technique of Value Stream Mapping to document the voice of the process. Value Stream Mapping is a powerful technique that has two steps. The first step is called a Current State Map and it looks at all of the actions (value added and non-value added) currently performed to bring a product from raw material into the arms of the customer. The information required to create a Current State Value Stream Map are customer requirements, process flow, machine uptime, raw materials, WIP inventory, human resources, information flow scrap rates, rework rates, etc. The Current State Map highlights sources of non-value added activity. The second step is to create a Future State Map. The Future State Map shows the desired state with non-value added activity removed. Some of the wastes identified in ACP’s value stream map were machine inefficiencies, poor product flow, rework, scrap excess inventory, unlinked processes and excess transportation.

*Voice of the Organization* – The voice of the organization is quite clear as expressed as a directive from ACP’s parent company, Hitachi Metals Ltd. “To be the low cost producer in the ductile iron suspension market segment”

*Voice of the Employee* – Formal and informal survey techniques can be used to evaluate the needs and desires of employees. ACP used informal techniques such as Supervisor interaction, safety meetings, and general employee meetings that the employees wanted an environment to work that will provide meaningful long-term employment.

## People and Their Roles

As true with all endeavors, the people involved make the difference between success and failure. The key roles in ACP’s Lean initiative are described below. With the exception of the Lead Facilitator, all of the other roles are not the primary function of the individuals.

*Steering Committee* – The steering committee is comprised of the department heads of manufacturing, technical services, purchasing and materials. Also on the steering committee are the Site Champion, Lead Facilitator, as well as a representative from Human Resources. The role

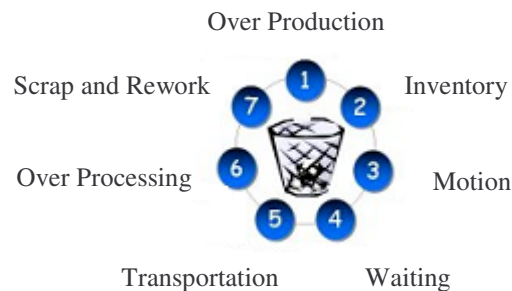
of the Steering Committee is to determine areas of focus for ACP PS by choosing when and where lean “events” should occur.

*Site Champion* – The site champion is responsible for keeping the program moving.

*Lead Facilitator* – The lead facilitator is an individual very familiar with lean tools. The lead facilitator’s role is to develop and nurture the other facilitators as well as to track progress of the lean activities to assure effectiveness and closure.

*Facilitators* – Individual facilitators were chosen from the hourly and salary ranks. The role of facilitators is to lead a group of fellow employees in continuous improvement activities. Facilitators were given much needed “Soft” skills training on communication, leadership, how to conduct meetings, and Working with Others. Each facilitator was also trained in the Kaizen (Continuous Improvement) process. The Kaizen process revolves around identifying and eliminating waste. Seven common forms of waste are identified below.

### Seven Forms of Waste



### The Eighth Form of Waste

By far the most difficult part of the Lean Journey is developing the culture that fosters the necessary environment for Continuous Improvement. The eighth and most dangerous form of waste is the under utilization of people. People are our greatest asset and we need to learn how to maximize their talents.

In addition to Kaizen and soft skills training and identification and elimination of waste, Facilitators were also trained on specific Lean Tools. Initially two facilitators were trained on each of the following tools

### Lean Tools

- **SMED – Single Minute Exchange of Dies**  
A series of techniques pioneered by Shigeo Shingo (Toyota) for changeovers of production machinery in less than ten minutes. The basic steps of SMED are;
  - Separate internal and external setup.
  - Convert internal setup to external setup
  - Streamline all aspects of setup operations

- **5S and Workplace Organization**

5S is the foundation for most lean activities. The purpose of a 5S program is to have abnormal conditions jump out at you. The five Ss are:

*Sort* - To clearly distinguish the needed from the unneeded. (Clear out & Classify)

*Straighten* – Keeping needed items in the correct place to allow for easy and immediate retrieval (Configure)

*Shine* - Keeping the workplace swept and clean (Clean & Check)

*Standardize* – Consistency applying 5S methods in a uniform and disciplined manner (Conformity)

*Sustain* - making a habit of maintaining established procedures (Custom & Practice)

At ACP, we added two more Ss they are Safety and Simple. In all Lean activities, Safety is paramount with Ergonomics a priority. Also, it is a goal of ACP Manufacturing to make things as Simple as possible for the operators on the shop floor.

- **Visual Factory**

A Visual workplace is a work area that is self-explaining, self-regulating and self-managing. Where what is supposed to happen does happen: on time, every day.

Characteristics of a Visual Workplace: - Physical Impediments to effective processing are removed - Processes are tightly linked and logically sequenced.

- Tools and fixtures have homes – no searching

- Information and material travel together

- Standards are clear and self-explaining.

Clear baseline for continuous improvement.

- **Value Stream and Sub Process Mapping**

A Value Stream Map is a diagram of all actions (both value added and non-value added) required to bring a product through from raw material to finished goods. A Value Stream Map is a 40,000-foot view of an operation. The goal of Value Stream Mapping is to reduce the time between Accounts Receivable and Accounts Payable by eliminating the waste in between. Sub Process mapping is a detailed view of each process in order to identify waste and generate ideas for continuous improvement.

- **TPM - Total Productive Maintenance**

A comprehensive program to maximize equipment availability in which production operators are trained to perform routine maintenance tasks on a regular basis, while technicians and engineers handle more specialized tasks.

The scope of TPM programs includes maintenance prevention (through design or selection of easy-to-service equipment), equipment improvements, preventive maintenance, and predictive maintenance. A goal of TPM is to only replace equipment due to technological changes, not because of equipment performance.

- **Poka-Yoke – Mistake Proofing**

A mistake proofing device or procedure to prevent a defect during the manufacturing process. Poka-yoke is designed to stop the movement of a component to the next station by using "fail-safing" techniques to eliminate errors or quality-related production defects as far upstream in the process as possible.

Facilitators were considered trained after a four-step process; Learn the Tools, Participate in an event, co-lead an event and lead an event. In order to get started, the lead facilitator was relied upon as well as help from the consultant.

### **Lean Events**

The application of lean tools occurs in the planning and implementation of Lean “Events”. A Lean “Event” should have a focussed scope and finite duration. The area of focus for Lean Events is determined by the Steering Committee based on information revealed by the Value Stream Map or from company goals such as improvement in Quality or Productivity. Most Lean Events utilize multiple tools. All events do require some level of 5S and Workplace Organization. A typical Lean Event will involve two facilitators, and 6-10 employees from both the salary and hourly ranks. Most Events require the participation of the employees for one week. The facilitators will spend time up front planning the events and more time on the back end following up with issues that are not completed within the week.

### **Sustaining the Progress**

In addition to the work of the steering committee and the facilitators, standing teams were established to foster the long-term growth of ACP PS and to attain the participation and buy in of all employees. The teams are chaired by members of the steering committee and are comprised of a cross-functional mix of employees. The four teams and their charter’s are;

#### **Safety Team**

- Accident Problem Solving
- Ergonomics
- Job Safety Analysis
- Behavior Based Initiatives

#### **Employee Team**

- Education
- Communication
- Rewards and Recognition

#### **Equipment Team**

- Preventive Maintenance Enhancement
- Equipment Breakdown Review
- Predictive Maintenance (Tribology, Thermography)
- Condition Based Monitoring (Real Time Vibration Monitoring)

#### **Production Team**

- Application of Lean Tools (Kaizen, SMED, Poka Yoke, Visual Factory)
- Developing Pull systems
- Single Piece Flow

## Summary and Conclusion

ACP Manufacturing has made much progress in its Lean Journey recognizing that it is a journey and not an event. Looking back at the progress made, it is rewarding. Looking forward to what needs to be accomplished is daunting. Along the path, some pitfalls were encountered. Right from the start the word on the shop floor was that LEAN was an acronym for “Less Employees Are Needed”. It has been and still is a challenge to involve all employees and change the culture. But the overall results are positive. Below are some of the improvements made in key business indicators by ACP from 2000.

- Safety 300% improvement (measured by OSHA recordables)
- Acceptability – 10% improvement
- Utilization - From 80% to 90%
- Productivity (measured by man-hours per ton) 50% reduction

## References

1. Liker, Jeffery. *The Toyota Way*. New York: McGraw-Hill. 2004.
2. Shingo, Shigeo. *A Revolution in Manufacturing: The SMED System*. Portland OR: Productivity Press. 1985.