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BEST PRACTICES WITH LEAN PRINCIPLES IN FURNITURE GREEN MANUFACTURING

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ABSTRACT

Today, industries such as furniture and carpentry sectors deal with a lot of environmental regulations. Lean is one of the production strategies whose fundamental principles drive the industry towards a more effective production of goods and services. The eco-efficiency concept is primary to sustainable development and intends to provide more value with less environmental impact. The aim of this paper is to identify and explore the contributions of lean with best practices to optimize and reduce the environmental impacts that naturally result from industrial activity.

Keywords - Furniture production, greenmanufacturing, lean management.

I. INTRODUCTION

Furniture manufacture involves the assembly of materials into furniture pieces and subsequent finishing. Materials in use include wood and wood-based products such as chipboards, veneer and plywood, as well as materials like metal, foam, and plastic. Product groups include kitchen furniture, office furniture, dining room furniture, bedroom furniture and upholstered furniture. However, this paper is aimed at the smaller furniture manufacturers and mainly focuses on best practices that are relatively simple and straightforward to implement in an existing facility. The paper contributes a brief overview of the basic steps for developing a waste reduction program and waste reduction opportunities, by using Lean and Green manufacturing principles.

II. LEAN MANUFACTURING SYSTEM

Lean manufacturing is an efficiency based system on optimizing flow to minimizing the wastage and using advance methods to improve manufacturing system by modified or change pre-existing ideas [3].Another definition say that Lean Manufacturing is a philosophy that aims to maintain smooth production flow by continuously identifying and eliminating waste resulting in increasing value of activities in the production process. Lean manufacturing approach makes an organization able to sustain market competition by improving its competence for better quality on time delivery with lower cost. Lean Manufacturing aims for Identification

and elimination of waste (any activity that does not add value to customer) [1].Lean manufacturing aims to continuous flow of all manufacturing processes with minimum as minimum wastage. The whole process must be free from waiting, disruption, and backflow.

The Basic Elements of Lean Manufacturing System are [6]: KANBAN, TPM (Total Productive Maintenance), JIT (Just In Time), KAIZEN (Change For Better), Quality Circles, TQM, Employee Involvement and 5's.

The Main benefits of Lean Manufacturing System are [6]: Improve productivity, Overall wastage reduction, Cost reduction, Reduce defects, and Overall quality improvement.

III. PRINCIPLES OF GREEN MANUFACTUIRNG

According to Balan (2008), Green manufacturing is an approach, that all innovative techniques towards effectiveenvironmental solutions that result in cost savings from reduced work handling, effluent control, and process automation or other environmental and operational benefits [5]. Faster and cheaper are no longer the only two success measures of manufacturing a product or evaluating an existing process line but also other success factors such as materials used in manufacturing, generation of waste, effluents and their treatment method, life of the product and finally, treatment of the product after its useful life are important elements that added by green manufacturing approach as success factors [4], [5]. The issues that green manufacturing is mostly addressing in process level, and accordingly the objectives of green manufacturing can be stated as the following [10]:

- Provide a cleaner source of energy through new technology or approaches.

-Decrease energy consumption in processes by implementing new technology or approaches.

- Convert pollutants and wastes into byproducts and promote their use and recycling along with that of the product in order to reclaim the energy expended in the process and conserve resource.

- Maximize yield and minimize waste effluents via process improvements, such as by tailoring feedstock selection, selecting proper fuel mix, automation, and establishing control strategies via sensors with real-time feedback loops that control process parameters.

Waste elimination is also a key issue of Green manufacturing. It concerns reduction or prevention of pollution to air, water and land as well as reduction of waste at source. Reuse and recycling are also part of the Green manufacturing concept to reduce the amount of waste produced. Waste is thus considered in a slightly different manner than within the lean concept, but the concepts share the view that resource productivity (Porter and van der Linde,95) is central aspects of a firm's competitiveness. Still, the literature presents a somewhat inconclusive view of the waste concept. As resource productivity is focused upon in both concepts, the "zero waste" goal of lean manufacturing is considered by some proponents to inevitably lead to pollution prevention (King and Lenox, 01).

TABLE: Summarizes similarities and Differences between the two concepts - Lean and Green [2].

No	Aspect	Lean Manufacturing	Green Manufacturing
01	Focus of the concept	Focuses on enhancing competitiveness through value creation for customers. Quality, waste minimization/elimination and delivery times are key issues.	Focuses on integration of environmental improvements of industrial processes and products. Reduction or prevention of pollution to air, water and land; reduction of waste at source; and minimization of risks to humans and other species are key issues.
02	Basic principles of the concept	Includes a number of principles related to four categories: philosophy (long-term thinking), process (elimination of waste), people and partners (respect, challenge and grow them), and problems solving	Includes principles related primarily to three categories: pollution prevention, reduction of use of toxic substances, and design for environment
03	Product and/or process focus	Mainly focus on processes, but the products' influence on performance of processes is strongly acknowledged.	Focus on both processes and products.
04	Methods/tools	Various tools are used for process Improvements	Various tools are used for improvements of environmental performance of processes and products
05	Employee involvement	Involvement of employees is key in order to achieve continuous improvement and learning.	Involvement of employees is key in order to implement measures for improving environmental performance of both processes and products
06	Supply chain involvement	Customer focus and involvement as well as close cooperation with suppliers are important	Involvement of suppliers is essential because sharing and integration of ideas for environmental improvements across organizational boundaries will support the achievement of high environmental performance in manufacturing

IV. STEPS FOR DEVELOPING A WASTE REDUCITION PROGRAM

The following are the steps recommended by EPA [12].

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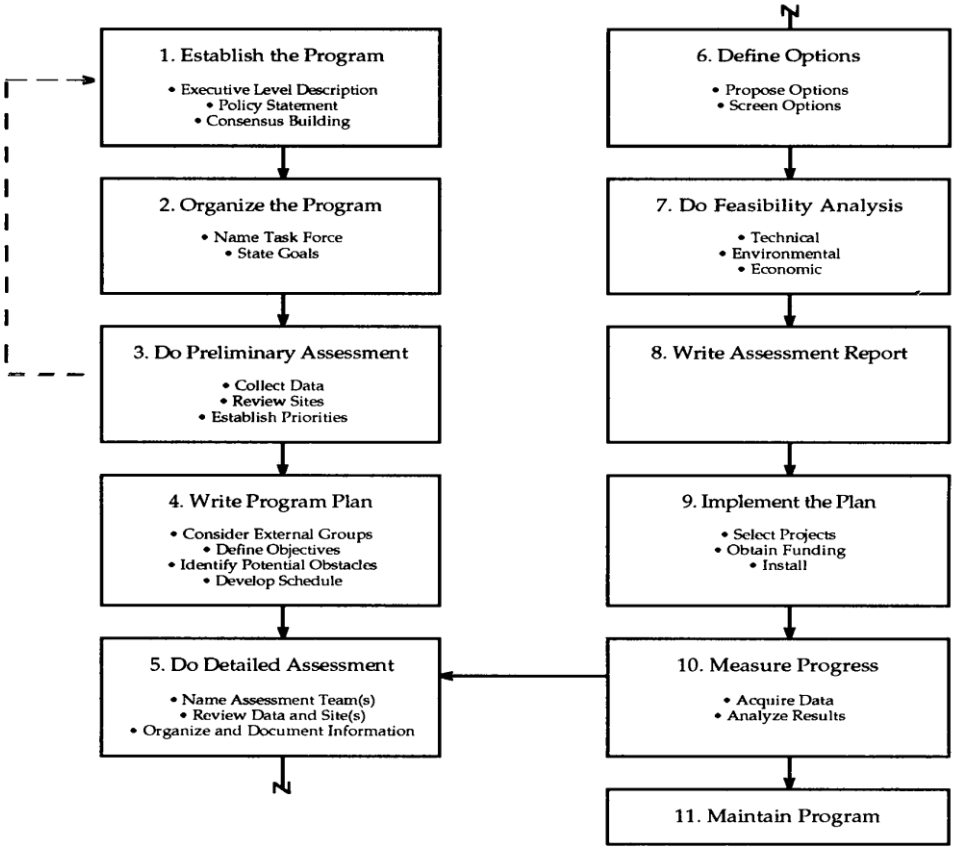

Fig.1 Developing a waste reduction program.

Some key factors for success include visible commitment from facility leadership, program ownership and support by all employees, multi-functional participation, establishment of waste reduction goals, management systems for tracking the types and amounts of materials, wastes and associated costs, and the measurement and celebration of progress.

V. FURNITURE MANUFACTURE

The main operations that can occur in furniture manufacture are as follows [11].

• Material preparation/processing: Components are sawed, planed, sanded, etc.

• Surface preparation: Sanding is used on raw surfaces and between coatings to improve adhesion, and is also used to remove coatings for rework.

• Organic coating: Covers powder and liquid coatings, both pigmented and clear. Multiple coating layers are applied, e.g. stain, filler, sealer or base coat, colour coat, and lacquer or topcoat. The type of coating equipment in use in furniture manufacture usually consists of spray equipment. The majority of spray equipment is manually operated. Roller, curtain, and dip coating are also used in a small number of specific applications.

• Curing: The coatings that have been applied are subsequently cured or hardened. This can be by heat/thermal means, while some more recent advances incorporate UV curing (larger facilities).

The main environmental considerations in furniture manufacture are:

•VOCs from coating, Particulates and dust, Hazardous wastes e.g. solvent containing materials.

• Other environmental considerations including timber resource depletion, noise, energy use, and wash water.

VI. TOOLS AND IMPLICATIONS FOR ENVIRONMENTAL PERFORMANCE AND BENEFITS

Lean tools can have a lot of implications to environmental waste in general. EPA's lean tools based researches conducted in organizations from various industries has provided an extensive knowledge regarding 5S, TPM, Cellular Manufacturing, JIT/Kanban, Kaizen Events, Six Sigma and their implications for environmental performance and benefits in waste reduction sense. This paper applied the lean tools and their implications for environmental performance and benefits from a broad environmental waste aspect including implications for chemicals and energy use [3], [7].

VII. BEST PRACTICES WITH LEAN AND GREEN

The best practices are those that are specific to particular unit processes involved in furniture manufacture. The following are the list of the areas of furniture manufacture considered [12].

1. Choice of raw material
2. Product design
3. Manufacturing processes

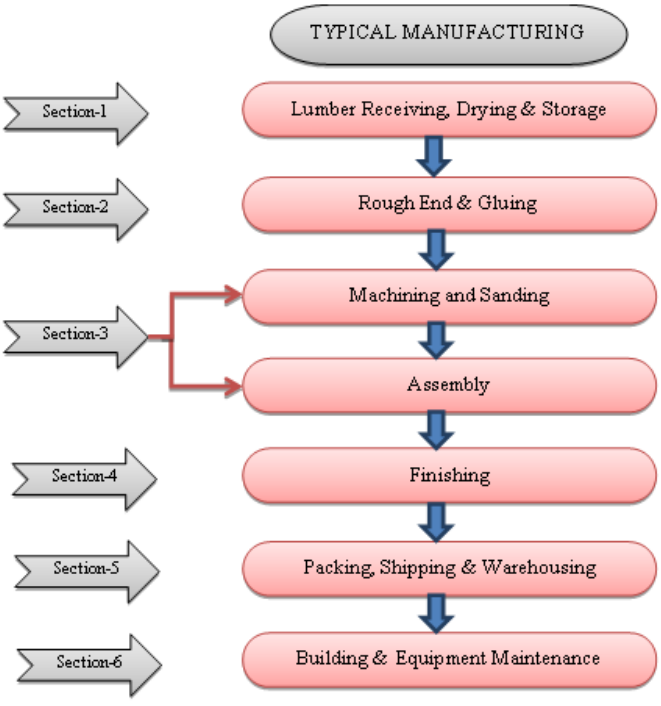

Fig.2 Lean manufacturing process for furniture industry.

7.1. Lumber receiving, drying and storage

The typical functions of lumber receiving, drying and storage include: unloading, grading, sorting, stacking, air-drying, kiln drying, dry shed storage, maintaining inventory records. The purpose of this process is to receive, prepare and maintain an adequate inventory of appropriate quality lumber for the subsequent manufacturing processes.

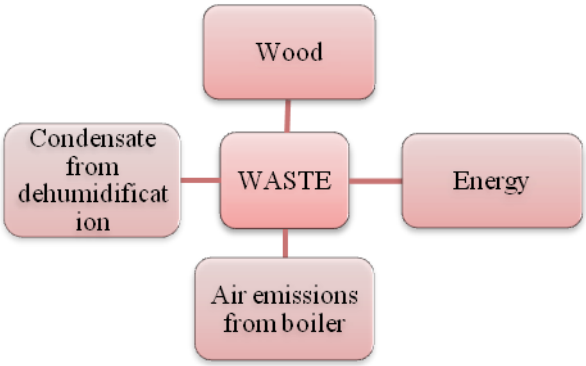

Fig.3 Common waste in Lumber Receiving, Drying & Storage.

The following arethe opportunities for waste reduction to follow.

1. Arrange Lumber Delivery to Minimize Inventory and Storage Time
2. Inspect and Sort Lumber
3. Separate Lumber by Kiln Sticks When Stacking
4. Use Stick Guides for Proper Alignment of Kiln Sticks
5. Improve Boiler Efficiency and Drying Klin Efficiency.
6. Improve Kiln Drying by Using High Speed or Variable Speed Fans
7. Dehumidification Drying and Air Vacuum Drying.
8. Vacuum Resistance Drying and Vacuum Press Drying.
9. Radio Frequency (RF) Redrying of Veneer
10. Provide Adequate Dry Shed Capacity and Environment.

7.2 Rough end and gluing

The typical functions of rough end and gluing include: cutting, sawing, gluing and joining. The purpose of the rough end and gluing is to remove defects convert the dried rough lumber into rectangular shapes or "blanks" of lumber or veneer that will be used to make the furniture components.

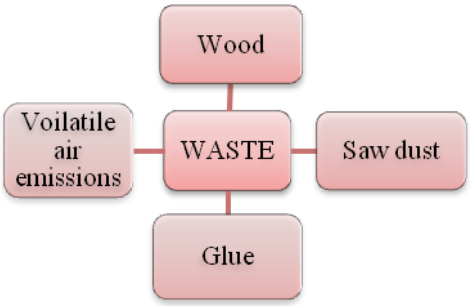

Fig.4 Common waste in Rough End & Gluing

The following arethe opportunities for waste reduction to follow.

1. Remove Defects from Rough Lumber Efficiently.
2. Use the Proper Glue and Gluing Techniques and Finger Jointing.
3. Recycle Wood Waste and Sawdust.

7.3. Machining, sanding and assembling

The typical operations of machining and sanding include: planning, molding, shaping, cutting and tenoning. Machining, or sometimes called the finish machine room, shapes the rectangular strips produced by the rough end and the plywood produced by veneering and laminating into the finished dimensions specified for the furniture part.

Sanding is basically rubbing the wood with an abrasive to smooth or prepare the surface for subsequent finishing or coating steps. Sanding can be done by hand or with sanding machinery. Sanding can take place on parts before furniture assembly, or take place during finishing in between coating steps.

The typical operations found in Assembly are: Assembly, fitting, repairing and inspection.

Assembly, or sometimes known as the cabinet room, takes the parts produced by previous operations and assembles them to make furniture. Component parts are glued, screwed, stapled, and nailed together to make the furniture.

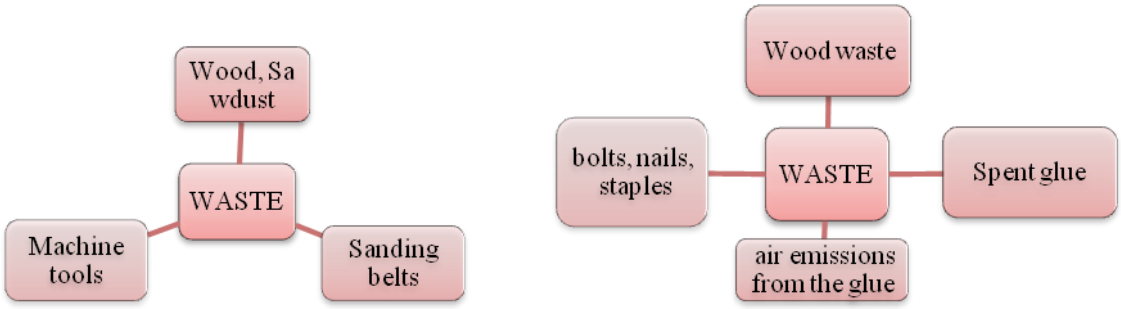

Fig.5 Common waste in machining, sanding and assembly.

The following are opportunities for waste reduction in Machining, Sandingand Assembly to follow.

1. Use Segmented Polishing Platens.
2. Cleaning Sanding Belts and Machine Tools.
3. Dust Collection, Recycling Wood Waste and Sawdust.
4. Use the Proper Glue and Gluing Techniques.
5. Recycling Wood Waste and Sawdust.

7.4. Finishing

The basic operations of the typical finishing process include:glue sizing or bleaching, cleaning / stripping,coatingdrying, sanding,rubbing / buffing, equipment cleaning, repair / touch-up.

The purpose of the finishing operations is to provide the furniture with a pleasingappearance, a feeling of smoothness, and protection of the wood.

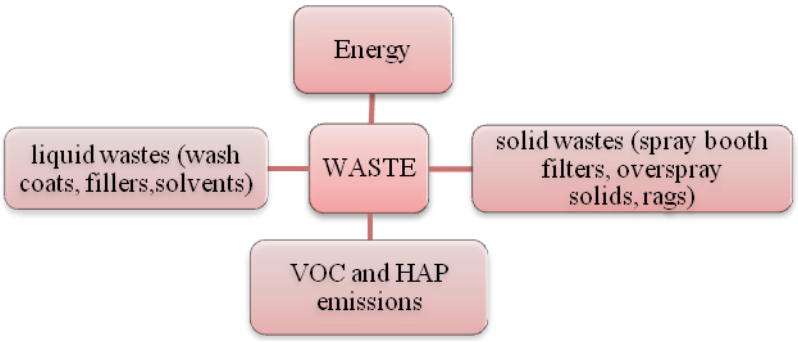

Fig.6 Common waste in finishing

The following are opportunities for waste reduction in Finishing are Coating formulations such as

1. Use of Waterborne Coatings.
2. Use of High Solids Solvent Based Coatings.
3. Use of Polyester / Polyurethane Based Coatings.
4. Use of CO2 Based System Coatings and Radiant Cured Coatings.

7.5. Packing, shipping and warehousing

Packing operations typically includes the following: Attaching hardware or inserting for customer attaching, securing drawers for shipment to prevent damage, placing the mirror in mirror frames to prevent breakage general cleanup, final inspection, touch-up, if needed, packing and labeling to provide the necessary protection to prevent damageduring shipping. Shipping and warehouse activities include finished product inventory control and material handling operations to move furniture inventory. Material handling equipment such as forklifts, overhead conveyors, and in-floor chain conveyors are commonly used.

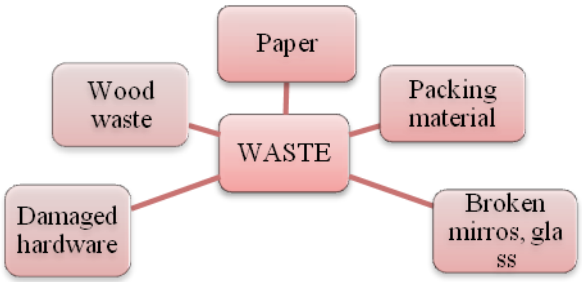

Fig.7 Common waste in packing, shipping and warehouse.

The following are opportunities for waste reduction in Packing, Shipping and Warehouse to follow.

1. Enhance Packaging Performance by Evaluating Damage History (thusreducing product damage and waste)
2. Enhance Packing Performance by Evaluating Packaging Water Resistance.
3. Decrease Toxic Metals Content of Packaging Materials.
4. Eliminate Ozone Depleting Substances in Packaging Materials.
5. Redesign Packaging to Minimize Volume and Weight - by EvaluatingPackaging Materials and Closure methods.
6. Improve Compatibility of Packaging Materials for Recycle and Develop Reusable Containers.
7. Recycle Other Wastes Produced in the Packaging, Shipping and Warehouse.

7.6. Building and equipment maintenance

Building and equipment maintenance is necessary to keep the facility and equipment operating. This means a variety of tasks and the generation of a variety of wastes.

Typical tasks include: repairing and maintaining equipment, installing new equipment and removal of old equipment, boiler operation and maintenance, repairing and maintaining the facility and grounds.

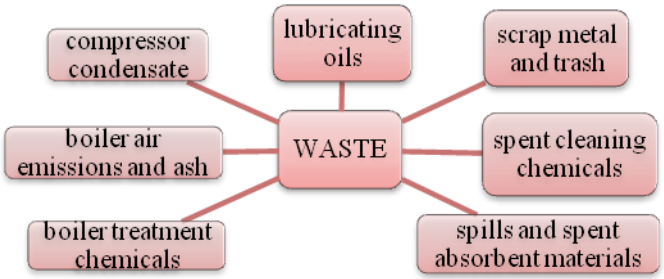

Fig.8 Common waste in building and equipment maintenance.

The following are opportunities for waste reduction in Building and EquipmentMaintenance to follow.

1. Use Synthetic Lubricating Oils with Longer Life.
2. Maintain Kiln and Controls.
3. Oil Clean Up with Recyclable Absorbents.
4. Segregate and Recycle Paper, Wood, Metals, Oils, Chemical Wastes and Glass.
5. Use Wood Boiler Ash as a Soil Conditioner.

VIII. CONCLUSION

Lean and Eco-efficient production systems are highly positive in their findings, resulting in strong evidence that lean has in fact a positive contribution in the improvement of the environmental performance. Green concept asserts reduction of material waste and emissions, fewer production steps which also support high resource productivity. Furthermore, the strong focus on continuous improvement in the Lean concept needs employee involvement and training. Improvements of environmental performance, as advocated by the Green concept, also require employee involvement and training. Both concepts require changed mindsets and establishment of company cultures supporting the philosophy underlying each concept. Another feature of the Lean concept is not only to solve any problem that occurs in manufacturing, but to avoid occurrence in the future. This displays similarities with the greenmanufacturing concept, which advocates source reduction. That is, attention should be paid to avoidance of negative environmental impacts rather than use of “end-of-pipe” solutions when the impacts occur. While the depth and variety of these manufacturers, investments are indicative of the furniture industry's movement towards greater use of renewable energy sources and "greening" manufacturing processes, there is still a tremendous amount of untapped potential, both for the industry, and for the nation as a whole. To realize this potential, companies need to take a holistic approach to updating their facilities and define a comprehensive sustainability strategy that is scalable, replicable, and economically viable. Simply

"greenwashing" a facility is not sustainable; the furniture industry needs to focus on the environmental impact of its decisions as well as the operational and economic impact of its investments in clean technologies.

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