MATTRESS RECYCLING COUNCIL
LEAN ASSESSMENT

SUMMARY REPORT

SUBMITTED BY:

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Contents

Introduction

In April 2019, MWS & Associates (MWS) was contracted to provide lean manufacturing assessments for California mattress recycling companies under contract to the Mattress Recycling Council (MRC). Lean is an improvement and problem-solving methodology that strives to reduce or eliminate activities that do not add value. It is based on a foundation of principles designed to not only quantify and eliminate waste, but also help organizations improve the way they do business.

Between April 29, 2019 and January 29, 2020, 12 recyclers participated in this effort. To facilitate each assessment, MWS trained a core team of employees on Lean principles and subsequently conducted value stream mapping, movement/transportation analysis and time studies in order to gather data on the site's current mattress recycling process and provide future state recommendations.

Following the assessments, each facility received a confidential report detailing the results of the analysis. Recommendations for improvement and the associated potential impacts were also provided. Each facility was subsequently given the opportunity to have a follow-up teleconference with MWS experts to review and discuss the data.

The purpose of this summary report is to provide an overview of all findings and identify opportunities for network-wide systematic productivity improvements and risk reductions associated with mattress recycling.

Process Workflow

Although the objective of each facility is the same - deconstruct mattresses and foundations and recycle the components, the processes to accomplish this task varied significantly due to plant layout, operational preferences and available resources. The most prevalent six sub-processes across all sites were Intake, Teardown, Quilt, Foam, Trash and Frames (See Figure 8.). The descriptions for each are summarized below:

1. The Intake sub-process begins with receipt of trailers of discarded mattresses and foundations (together referred to as "units") or consumers dropping off discarded units in a designated external area. All units are transported and staged in each facility using forklifts.

2. The Tear Down sub-process begins once a dismantler retrieves a unit from the dismantlers' queue and moves it to the workstation. This sub-process concludes when the unit separator has separated the mattress into its sub-components.

3. The Quilt sub-process begins when the dismantler places the quilt onto a quilt hand truck. The baler operator then transports the quilt hand truck to the baler queue. The Quilts are held until a sufficient amount of material is accumulated, and the baler is available. The Quilts are then baled. The forklift transports the baled quilts to the storage area. Baled quilts wait in the storage area until a truckload is accumulated. The forklift then loads the baled quilts onto an outbound truck for recycling in secondary markets.

4. The Foam sub-process begins when the dismantler transports the foam using a hand truck to the baler queue. The Foam is then baled. The forklift driver transports the baled Foam to the storage area. Baled Foam is held in the storage area until a truckload is accumulated. A forklift then loads baled Foam onto an outbound truck for recycling in secondary markets.

5. The Trash sub-process begins with the dismantler placing the trash next to the workstation. The dismantler then transports the trash bundle to the trash truck or roll-off container.

6. The Frames sub-process begins when the dismantler stacks dismantled frames next to the workstation. Depending on the frame type (mattress or box spring), the process will follow these steps: Forklift will transport frames (metal coil frame, white pocket coil, all wood frame) to storage areas and then to the metal baler queue. The metal baler will then bale the metal. The separator stacks the separated wood into clean or dirty stacks. The forklift then transports dirty wood to the trash bin. Clean wood is transported by forklift into a separate wood bin for recycling in secondary markets. The forklift transports baled (or loose) metal on to a flatbed truck or roll-off for sale in secondary markets.

Key Findings

All assessed facilities commonly exhibited significant potential to improve productivity and reduce process risk. While each facility had its own unique opportunities for improvement, some opportunities were found across all recyclers.

Each of the site's activities were categorized into value added (VA), business non-value added (BVNA) and non-value added (NVA). (See Figure 1).

- **Value-Added**: An activity is value-added if a customer is willing to pay for; it changes form, fit or function of a product or service; it converts input to output; it is not waste

- **Non-value Added (NVA)**: sometimes called Type II NVA. These activities are unnecessary: they provide no value for internal or external customers and can be immediately eliminated.

- **Business Value Added (BVA)**: sometimes called Type I NVA. These activities provide no value to customers (as defined above) but are necessary given current process limitations. Common examples are inspections, management approvals, most quality assurance activities; technical support activities.

On average, nonvalue-added activities for all recycling facilities accounted for 24% of total process time. A deeper dive into efficiency losses point to four common issues; less than optimal plant configurations, data management limitations, large queues due to excessive inventories and sub-process bottlenecks.

1. Plant Layouts: For the majority of facilities, MWS found the primary source of inefficiency to be related to significant manual or mechanical movement of material between queues and believes that all facilities would benefit from reconfiguring process workflows and plant layouts. Each facility was provided with a recommended new configuration and the associated estimate of the potential impact on productivity.

2. Data Management: The potential for reporting errors, process reworks and communication gaps between MRC, collection sites and recycler processes were found to be the most significant contributor to process risk. It was determined that the implementation of frequent physical inventory counts and manual data entries at each stage of the process were critical to the efficient management of workflow. Increased emphasis on worker training and development of standardized procedures would be beneficial to all recyclers.

   MRC may also find it valuable to investigate means to more robustly improve connectivity through the supply chain. Better data from the collection and transportation processes may improve the efficiency of the site sub-processes.

3. Inventory Management. During most of the assessments, site operations were hampered by excessive storage of inventory. Large queues of materials in various stages of the recycling process occupied a significant amount of covered and uncovered space, resulting in unnecessary movement and the reduction of overall throughput. In the process risk analysis, MWS also noted significant risks in the stacking and movement of baled metals and other materials. In addition to the impact on forklift operations, significant inventory queues impacted the efficiencies of some subprocesses. Kaizen events and workshops to establish min./max. inventory guidelines and continued lean process training would be beneficial to all recyclers.

4. Process Bottlenecks. Analysis of workflow was conducted both at the subprocess level and by employee. At the subprocess level, frame and foam recycling processes consumed about 63% of total process time. For all recyclers, these subprocesses yield revenue generating materials. Considerable time is spent on value-added activities such as separating materials, baling and preparing for shipment. In these sub-processes, follow-up Kaizen events and workshops to investigate potential process improvements

were recommended. It is believed that best practices in other industries and perhaps improved automation may be beneficial for some facilities.

At the employee level, the most common bottlenecks were associated with forklift and baler operation. With forklift operation, we observed a much higher level of non-value-added activity mostly attributed to the previously discussed excess movements due to inefficient layouts and large queues of inventory. While baler operation is a common bottleneck, it was found that this step has a very high percentage of value-added activity. We conclude that for some facilities, additional baler capacity would significantly improve throughput.

The aggregate data supporting these findings is provided in Figure 2. Pareto of Process Cycle Times and Figure 3. Pareto of Process Risk Causes.

Process Throughput

As illustrated in Figure 4, MWS found a wide variance in process Cycle Time, which is the amount of time it takes for one mattress to go through all sub-processes. Across the twelve sites, times ranged from 1.48 minutes per unit to 18.85 minutes per unit. This wide variance is caused by a variety of factors including resource availability and the level of reliance on mechanical versus manual processes.

Conclusions

Based on the opportunities for improvement it was determined that all recyclers collectively have the potential to increase their productivity by an average of 30%. This would be achieved by focusing on reducing non-value-added activities within particular sub-processes (See Figure 5). The overall average time to process a unit was 7.6 minutes. With the adoption of lean methodologies, MWS estimates this could be reduced to an average of 5.6 minutes per unit. (See Figure 6.)

The largest bottleneck for all recyclers is the frames sub-process which accounts for 46% of total process time. A review of individual reports finds that most sites have considerable percentages of non-value-added activity. We believe that focus on workflow, equipment and procedures in the frames sub-process would have the largest impact on overall mattress recycling efficiency and profitability.

General Recommendations

Based on individual site profiles (throughput, resource availability/capabilities, plant layout, subprocess activities, etc.) at the time the lean manufacturing assessments were conducted, specific recommendations were made in order to improve performance and ensure a positive impact on operations.

Below are some additional recommendations that should be employed at all MRC sites to further streamline efforts, increase productivity and further enhance overall operations.

1. Provide initial Lean Training to all recycler employees

   Lean methodologies are most beneficial when the entire facility has a basic understanding of concepts and tools. Due to time and resource constraints during the initial Lean manufacturing assessments, only a small core team at each site was provided an overview of Lean, and it is recommended that all recycler employees be introduced to the associated concepts.

2. Provide in-depth Lean training to management and core teams

   To ensure that Lean practices and principles remain at the forefront of operations, it is imperative that there are champions within the organization who understand the nuances and can readily assist their teams in reaching their future states. It is recommended that the management and core teams receive additional Lean training and become certified green belts.

3. Evaluate the Inputs (conduct lean assessments in the areas of collection and transportation)

   It is recommended that lean assessments be conducted in the areas of collection and transportation in order to better understand the inputs to the recycler process. It should be noted that efforts are already underway in this area.

4. Evaluate the Outputs (assess the recycled commodities market) in order to identify other means of increasing profitability

   About 80% of a discarded mattress is recyclable. Recyclers under contract to MRC are expected to recycle at least 75 percent by weight of all units. While recyclers generate some revenue from the sale of reclaimed materials, it does not offset operational costs of each facility. It is important to have a comprehensive understanding of secondary markets and the opportunities to bolster recycling efforts and revenue streams.

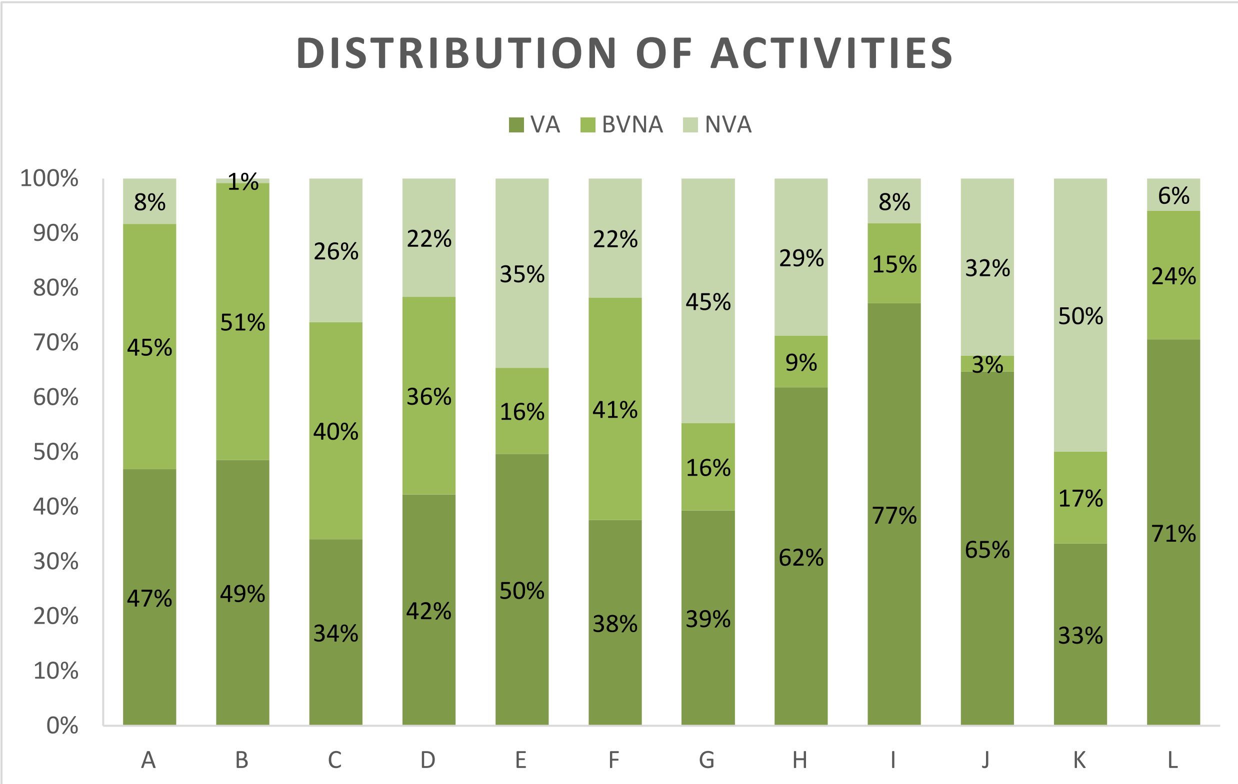

Figure 1. Distribution of Value-Added, Business Non-Value-Added (BVNA) and Non-Value-Added (NVA) activities among recycling facilities.

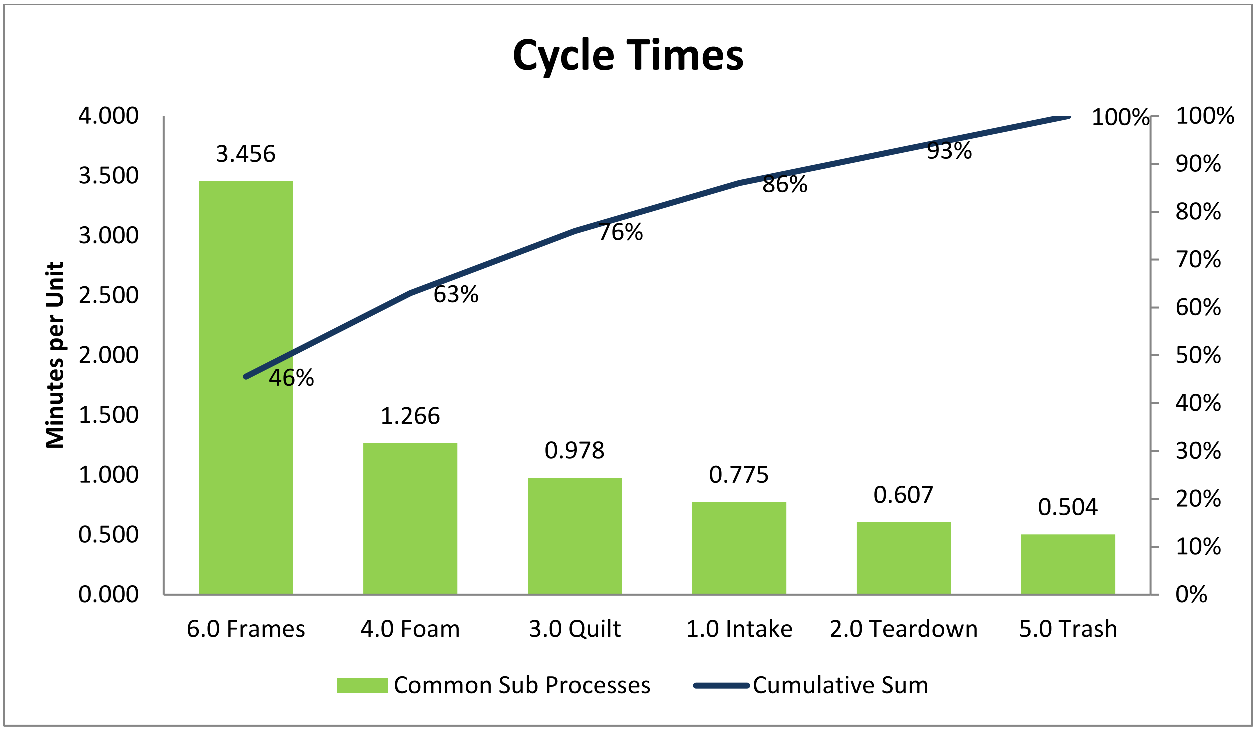

Figure 2. Ranking of Aggregate Production Cycle Times by Sub-process

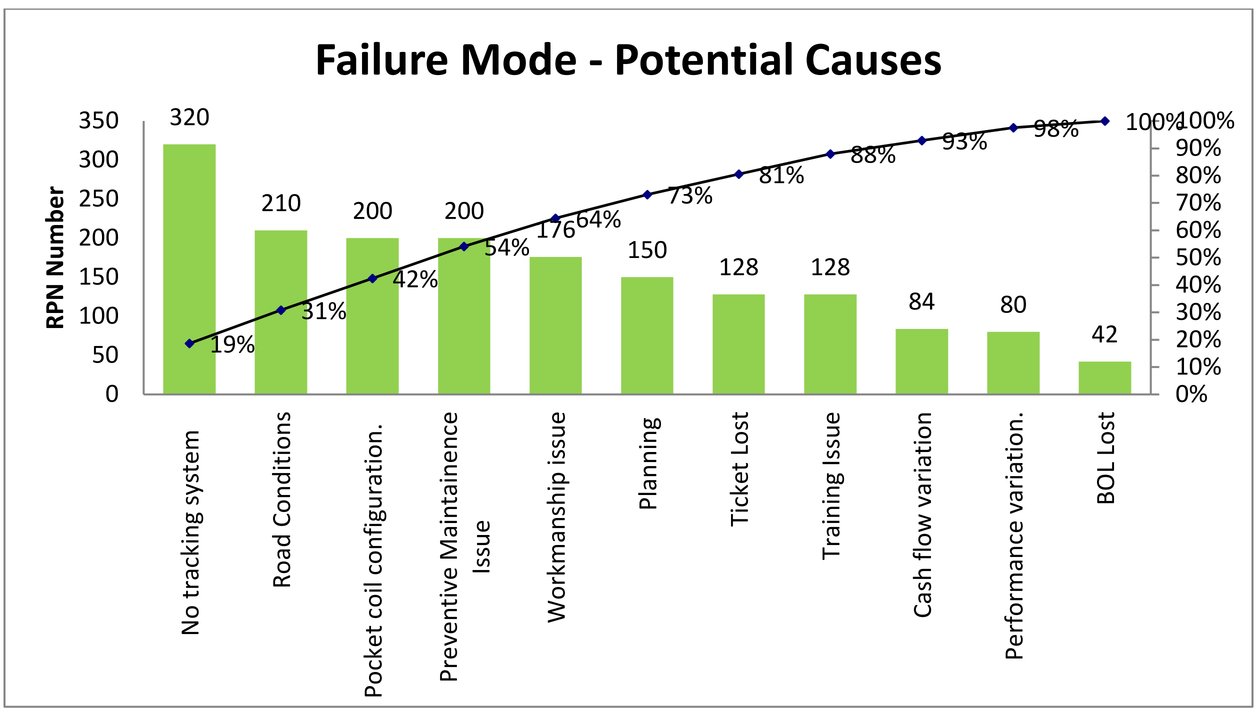

Figure 3. Potential causes of process risks by aggregate risk priority number (detail on RPN calculation methodology is given in Figure 7)

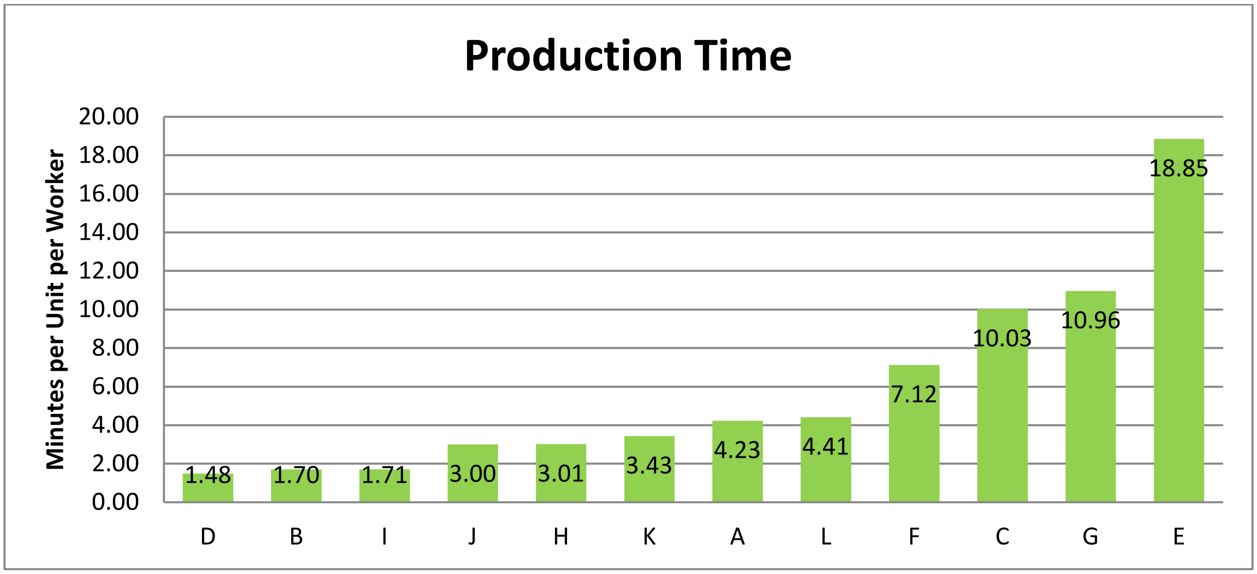

Figure 4. Production Cycle Time variance among assessed recycling facilities.

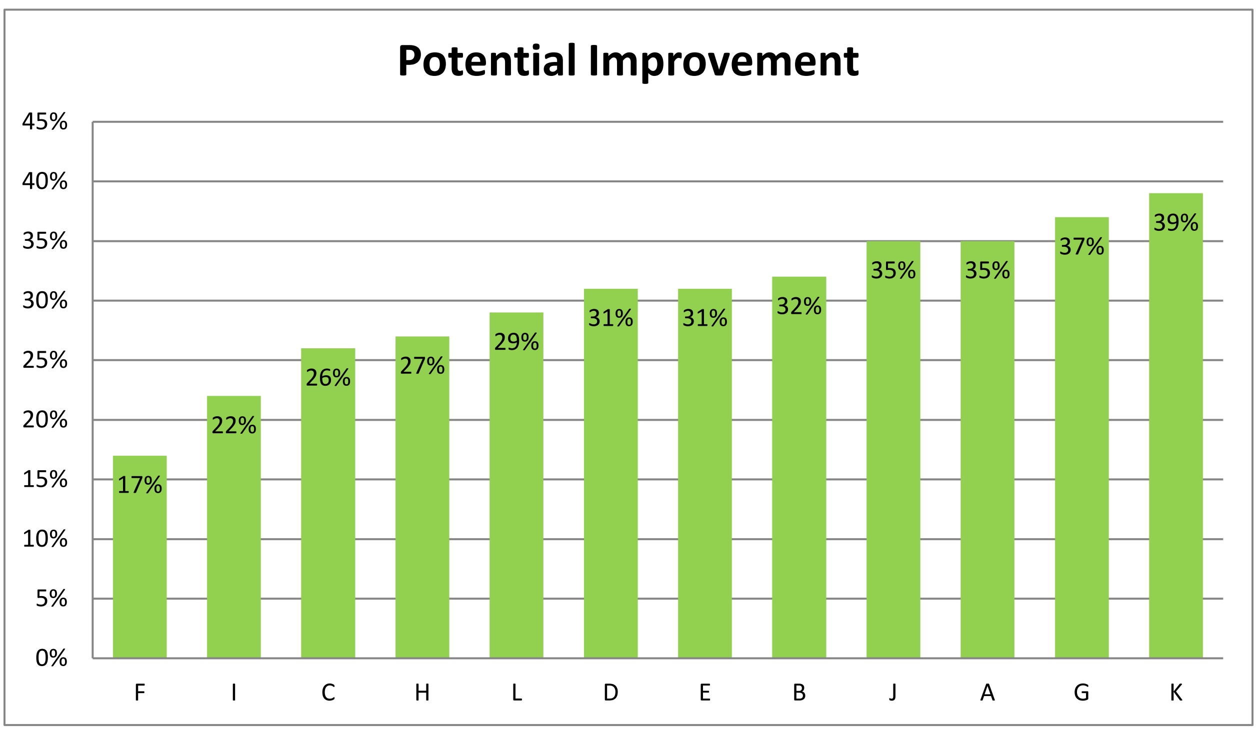

Figure 5. Potential Productivity Improvement by assessed recycling facility

Cycle Times – Current State (minutes per unit)*

Task Number	Task Description	Value-Add Time	BNVA Time	NVA Time	Total Time
1.0 Intake	1.0 Intake	0.253	0.282	0.240	0.775
2.0 Teardown	2.0 Teardown	0.442	0.152	0.013	0.607
3.0 Quilt	3.0 Quilt	0.558	0.280	0.140	0.978
4.0 Foam	4.0 Foam	1.004	0.064	0.198	1.266
5.0 Trash	5.0 Trash	0.231	0.235	0.039	0.504
6.0 Frames	6.0 Frames	0.690	1.314	1.453	3.456
	Total Times:	**3.179**	**2.326**	**2.082**	**7.588**

Cycle Times – Future State (minutes per unit)

Enter Takt Time:	1.24	**Green indicates improved timing**			
Task Number	**Task Description**	**Value-Add Time**	**BNVA Time**	**NVA Time**	**Total Time**
1.0 Intake	1.0 Intake	0.253	0.085	0.072	0.410
2.0 Teardown	2.0 Teardown	0.442	0.046	0.004	0.491
3.0 Quilt	3.0 Quilt	0.558	0.084	0.140	0.782
4.0 Foam	4.0 Foam	1.004	0.064	0.059	1.128
5.0 Trash	5.0 Trash	0.231	0.070	0.039	0.340
6.0 Frames	6.0 Frames	0.690	1.314	0.436	2.440
	Total Times:	**3.179**	**1.662**	**0.749**	**5.591**

Figure 6. Current State and Future State Potential Productivity improvement by sub-process

*Yellow highlighted areas reduction opportunities identified in the assessments.

RATING	DEGREE OF SEVERITY	LIKELIHOOD OF OCCURRENCE	ABILITY TO DETECT
1	Customer will not notice the adverse effect or it is insignificant	Likelihood of occurrence is remote	Sure that the potential failure will be found or prevented before reaching the next customer
2	Customer will probably experience slight annoyance	Low failure rate with supporting documentation	Almost certain that the potential failure will be found or prevented before reaching the next customer
3	Customer will experience annoyance due to the slight degradation of performance	Low failure rate without supporting documentation	Low likelihood that the potential failure will reach the next customer undetected
4	Customer dissatisfaction due to reduced performance	Occasional failures	Controls may detect or prevent the potential failure from reaching the next customer
5	Customer is made uncomfortable or their productivity is reduced by the continued degradation of the effect	Relatively moderate failure rate with supporting documentation	Moderate likelihood that the potential failure will reach the next customer
6	Warranty repair or significant manufacturing or assembly complaint	Moderate failure rate without supporting documentation	Controls are unlikely to detect or prevent the potential failure from reaching the next customer
7	High degree of customer dissatisfaction due to component failure without complete loss of function. Productivity impacted by high scrap or rework levels.	Relatively high failure rate with supporting documentation	Poor likelihood that the potential failure will be detected or prevented before reaching the next customer
8	Very high degree of dissatisfaction due to the loss of function without a negative impact on safety or governmental regulations	High failure rate without supporting documentation	Very poor likelihood that the potential failure will be detected or prevented before reaching the next customer
9	Customer endangered due to the adverse effect on safe system performance with warning before failure or violation of governmental regulations	Failure is almost certain based on warranty data or significant failure testing	Current controls probably will not even detect the potential failure
10	Customer endangered due to the adverse effect on safe system performance without warning before failure or violation of governmental regulations	Assured of failure based on warranty data or significant failure testing	Absolute certainty that the current controls will not detect the potential failure

RPN NO:	SEV x DET x OCC	
RPN Actions		**Notes**
1 - 25	No Action Needed	**But - can be taken especially if the SEV is high**
26 - 50	Action Needed	**Action is Needed**
51 -	High Priority	**Action Must be taken**

Figure 7. Risk Priority Number Calculation

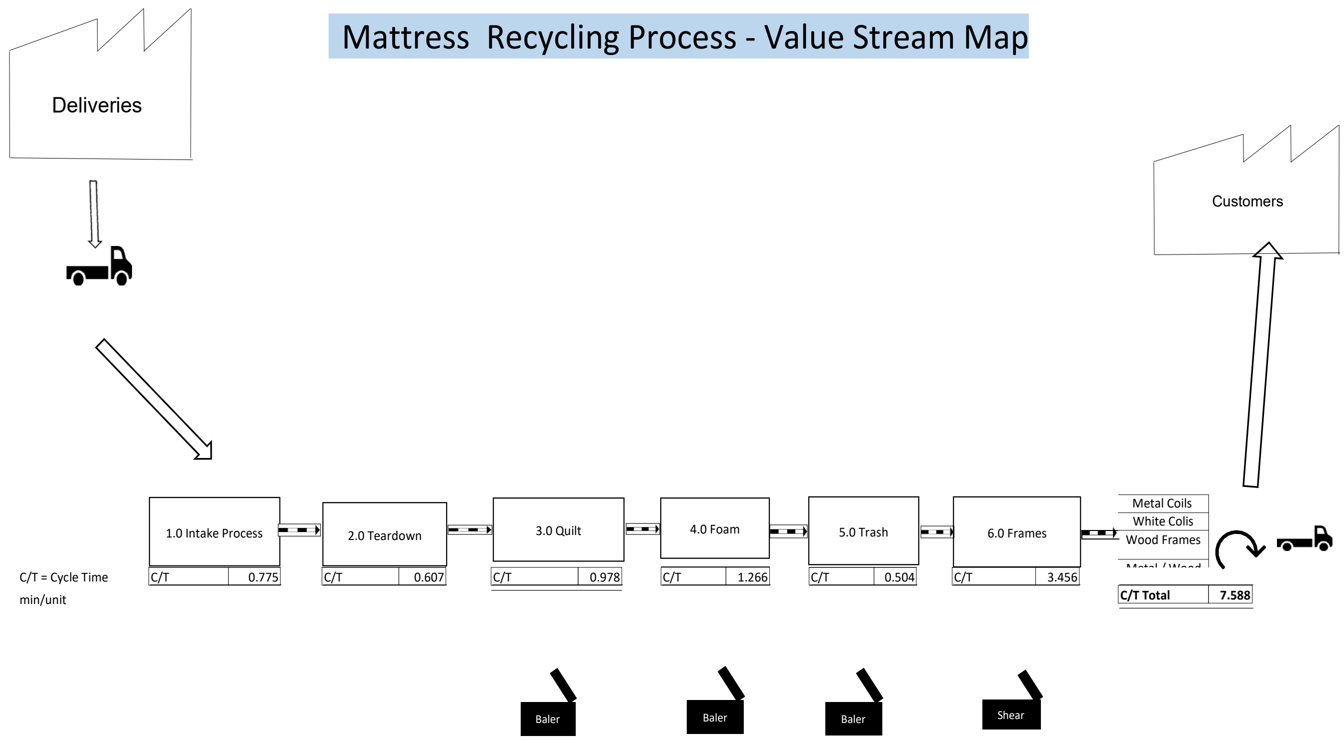

Figure 8. Value Stream Map of Primary Sub-Processes

Appendix: Glossary of Terms

VA: Value-Add Time in minutes. Measure the task time spent performing customer value added activities, e.g., adding a customer required feature with the customer willing to pay for the work. A value-added activity must be done right the first time.

BNVA: Business Non-Value Add Time in minutes. This is also known as: Type I Muda (Waste). Although Non-Value Added, the task is Necessary for operation.

NVA: Non-Value Add Time in minutes. This is also known as: Type II Muda (Waste)

Cycle Time: Cycle time includes process time, during which a unit is acted upon to bring it closer to an output, and delay time, during which a unit of work is spent waiting to take the next action.

Takt Time: TAKT Time is the speed with which the product needs to be created in order to satisfy the needs of the customer. The TAKT Time Formula = (Net Time Available for Production)/ (Customer's Daily Demand).

PFMEA: Process Failure Modes and Effects Analysis: is a methodical Risk Analysis approach used for identifying risks on process changes. The Process FMEA initially identifies process functions, failure modes and their effects on the process. If there are design inputs, or special characteristics, the effect on end user is also included.

RPN: Risk Priority Number: Risk Priority Number (RPN) is a calculation to sort the risks from highest to lowest. The RPN is calculated by multiplying the three scoring columns: Severity, Occurrence and Detection.

KAIZEN: Kaizen involves breaking down a process, removing any unnecessary elements, and then putting it back together in a new and improved way. The process should now work more smoothly and fully utilize the skill sets of everyone involved.

KPI: Key Performance Indicator. A metric used to gauge organizational performance.

Lean Manufacturing: Lean manufacturing or lean production is a systematic method for the minimization of waste within a manufacturing system, without sacrificing productivity.

Process Map: A Process Map is a map of the structured set of activities that transforms inputs into outputs.

Pareto Chart: A Pareto chart is a type of chart that contains both bars and a line graph, where individual values are represented in descending order by bars, and the cumulative % is represented by the line.