Value Stream Mapping: An Analytical Work Study on Auto Beam Saw Machine in a Furniture Industry

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Abstract

Auto Beam saw machine is one of the most powerful machines for cutting wooden boards such as Medium- density fiberboards, plywood, laminated boards, etc. It has an immense capability of utilizing both time andcost. It stands at the entrance of a furniture manufacturing section as it primarily cuts the solid board into different small pieces. This study aims to map the whole activities of the man-machine interface of this machine in a furniture factory and determine the existing capacity. This study finds out the non-value-added activities using Value Stream Mapping. Removing these activities can increase the overall utilization. The study goes further by simulating alternative outcomes altering those non-value-added works comparing the results and finding correlation among the variables. A capacity equation was found from the survey regarding those variables which is useful to calculate the overall efficiency. Based on the survey, additional recommendationsfor future aspects of this study were provided to derive a constructive solution for the best utilization of the machine.

Keywords: Value stream mapping, Lean tools, work-study, simulation, capacity utilization.

1. Introduction.

In the manufacturing industry, processes need to be waste-free to utilize man, machine, and materials as well as achieve the targeted lead time to meet customer demand [1]. Lean manufacturing is a continuous improvement philosophy that is related to the Kaizen and Toyota production systems [13]. The lean philosophy focuses on increasing product value by minimizing waste and optimizing customer satisfaction [2]. The goal of lean manufacturing is to reduce costs by recognizing and getting rid of non-value-added tasks, eliminating waste from the production process, and lessening work-in-progress [3]. Hence, lean wastes need to be addressed in the process, and to do so, one of the most widely used lean tools is VSM [4-6]. VSM identifies the non-value-added activities present in that particular process, and on top of it, the activities can be categorized into lean waste like transportation, inventory, motion, waiting, overproduction, over-processing defects, and unutilized talent. The furniture industry makes no difference in this scenario [7-10]. In the furniture manufacturing industry, an auto-beam saw machine stands at the entrance as it primarily cuts the solid board into small pieces. Therefore, the capacity utilization of this machine plays a significant impact on board-based furniture [11-12]. The objective of this research is to map the entire activities of the man-machine interface of this workstation in the furniture industry. This study identifies the non-value-added activities and categorizes the lean wastes by using VSM. Finally taking necessary measures to eliminate the non-value-added activities by eliminating the lean waste and utilizing the machine more effectively than before.

2. Methodology.

The methodology is depicted in the following flowchart-



3. Data analysis and discussion

To identify the lean wastes in the process and to mitigate them two major VSM tools [14] were used: Process mapping (Fig 1) and value-added, non-value-added matrix (Table 2). To create a value stream map for the existing system the data informatics are shown below:

Table 1: Data Informatics

Observation period	10 working days
Type of materials	Veneer board
	Plain board
	Melamine board
Material thickness	15 mm-18 mm
No of workers	5
Machine	Automatic Beam saw

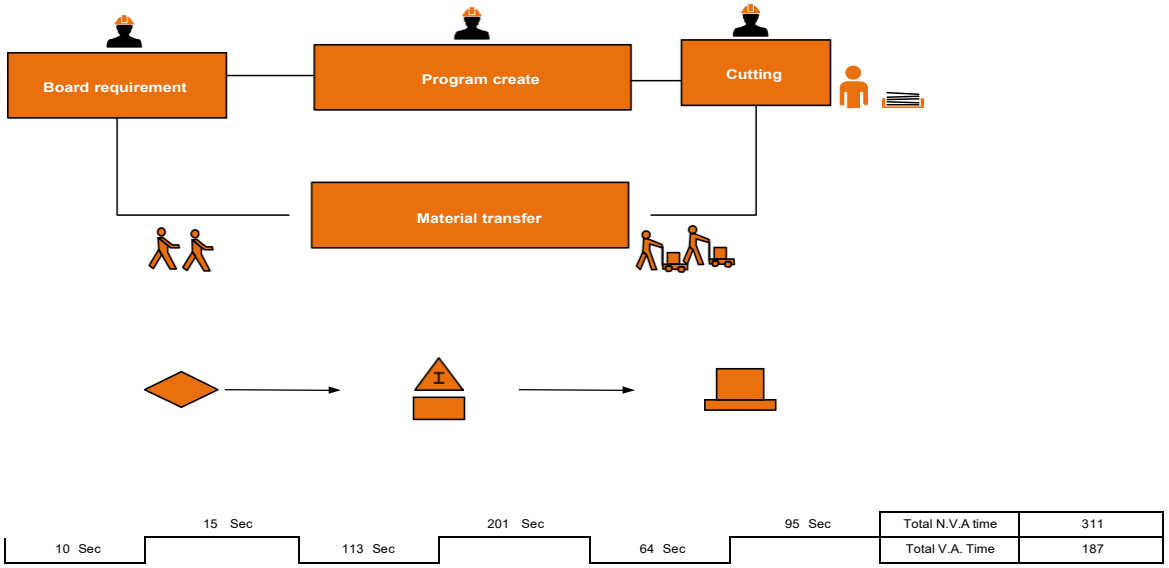


Fig 1: value Stream mapping for board cutting

Based on the observation the initial value stream map (Fig 1) is created: the whole process is broken into three major activities- Program set, material transfer, and cutting operation where the first two are the prerequisites and both activities run concurrently. The process-related value-added and non-value-added times are shown at the bottom and the types of processes are displayed with their respective symbols in the middle. The map is shown for one standard cycle. We calculated the times for one cycle based on our observation period. These activities are broken down into value-added and non-value-added matrices where we selected a type for every activity [14] and showed the non-value-added and value-added attributes. (Table 2)

Table 2: Value added and Non-value-added activity matrix

Activities	**Type**	**Value added activities**	**Time (Sec)**	**Non-Value-added activities**	**Type (Lean waste)**	**Time (Sec)**
Board requirement	Measurement & Inspection	Determine the type of boards	2			
		No. of boards required	2.5			
Store to machine	Transport	Loading	18	Finding the right board	Motion and transportation	10
		Counting	3	Arrangements of board		5
		Moving	15	Loading from over-height		20
				Miscellaneous		41
	Total		36			76
Program file	Measurement & Inspection	Input part dimension	45	Offcut identification	Over-processing	10
		Input repetition	2	Offcut utilization		115
		Input direction	15			
		Determine rotation	15			
	Total		77			125
Board cutting	Operation	Unload from trolley	10	Scrap collection	Over-processing and motion	30
		Load into machine	10	Rotation		30
		Cutting	24	Unload off cut		10
		Unload parts	15	Find a place for off-cut		20
		Arrange product parts	5	Arrange off cut		5
	Total		64			95

The board requirement calculation is a prerequisite for the whole operation. At first, the requirement is calculated as per the production plan, and then the rest of the work is started. From (Table 2) the non-value- added activities for each type are segregated. The types of non-value-added activities were defined according to lean philosophy. The overall process cycle time cannot be estimated by directly summing these activities asthere is some concurrency. Hence two Gantt charts (Fig 2) combined with a single phase and then 10 continuouscycles are shown.

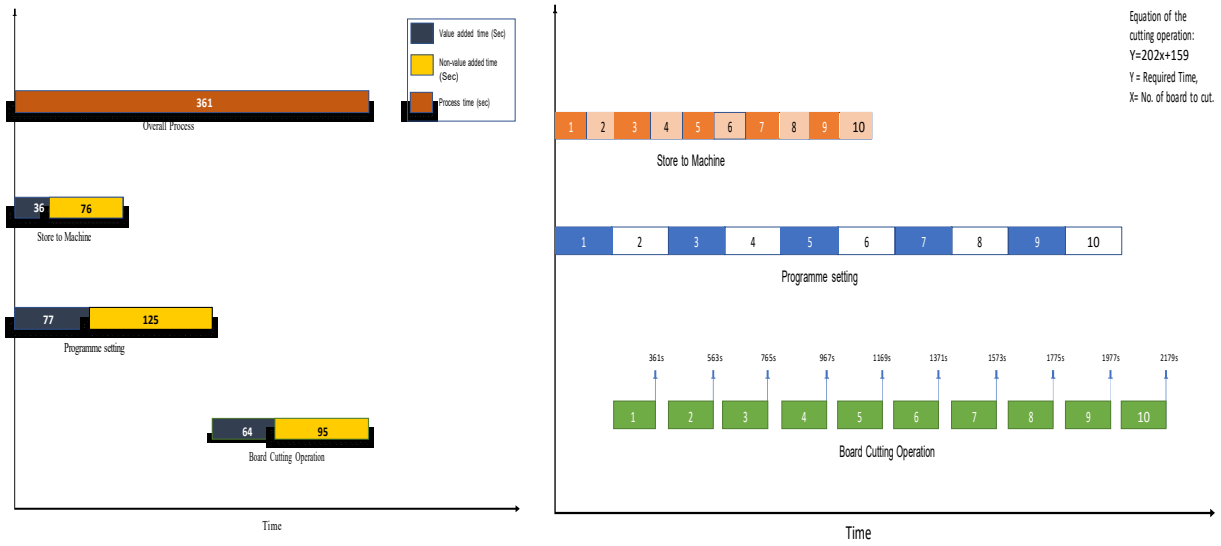


Figure 2: Cycle time breakdown for 1 and 10 continuous cycle

From our observational data, we tried to generate a generic equation to determine the cycle time. The effect of non-value activities is highlighted in the first chart where only after the first two activities the cutting is started. However, the material transfer and program setting activities start for the next cycle as they don't need any preparation. Then required boards are transferred from the store based on the daily requirement and the program is created and saved. When a program is set and the material is also transferred the cutting process begins. Using the observed dataset, a linear relationship is found by Python programming and the existing process equation stands as follows:

$$y = 202 * x + 159 \quad (1)$$

By identifying the non-value-added activities some required steps are recommended [14] to eradicate them completely or partially.

Table 3: Initiatives for System Improvement

Activities	Non-Value-added activities	Time (Sec)	System improvements	New time
Store to machine	Finding the right board	10	Full layout of the store considering the daily use and transfer system of the material. Using Marked areas for different types of boards and setting up standard heights for the stacks	0
	Arrangements of board	5		0
	Loading from over-height	20		0
	Miscellaneous	41		0
	Total	76		0
Program file	Offcut identification	10	Setting the program file in advance in MPS and reducing the off-cut.	0
	Offcut utilization	115		45
	Total	125		45
Board cutting	Scrap collection	30	Determining the rotation while programming and automatically minimizing the rotation. Setting up a whole loading-unloading plan in such a manner where the off-cut and parts are loaded at the same time and a layout for off-cut and scrap arrangement is established	0
	Rotation	30		0
	Unload off cut	10		0
	Find a place for off-cut	20		0
	Arrange off cut	5		0
	Total	95		0

For these new arrangements two Gantt charts are shown based on one cycle and 10 continuous cycles and we predicted a new equation (Eqn 2) for the process:

$$y = 122 * x + 64 \quad (2)$$

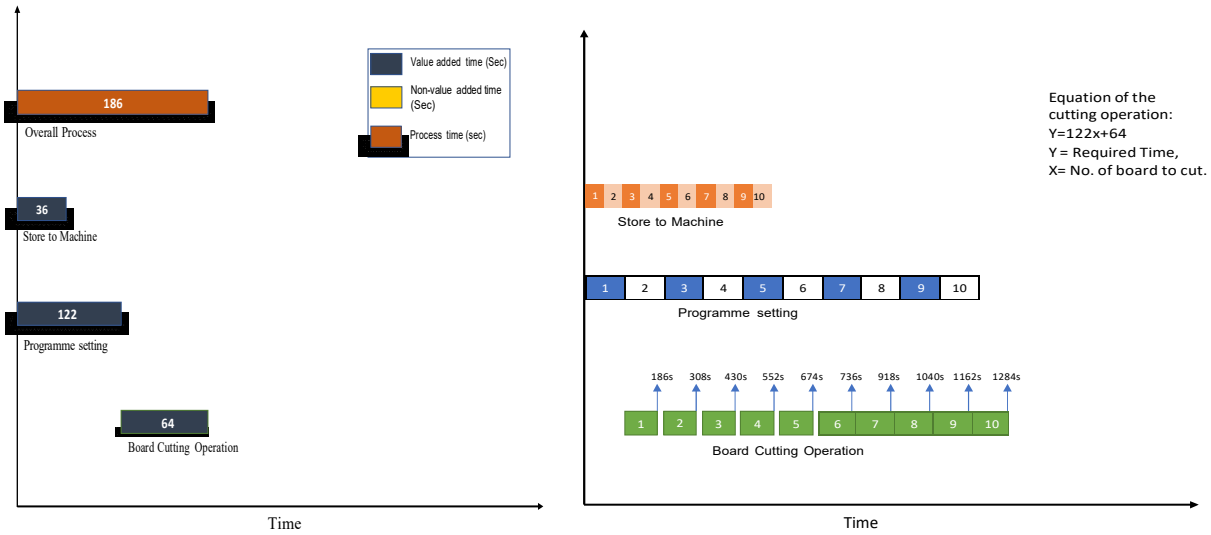


Figure 3: Alternative operation cycle

By simulating two scenarios, an overall comparison has been given in the table below where it is shown that the removal of no-value-added activities can enhance the capacity by up to 66% and reduce 40% of the cycle time which can lead to productivity growth by more than 50% (Table 4)

Table 4: Comparison of the current and future states

	Cycle time (Sec)	Required time for 10 board operation	Equation	Daily capacity
Current state	202	2179	Y = 202*X+159	124
Future state	122	1284	Y = 122*X+64	206

Reduction in cycle time	40%
Capacity enhancement	66%
Productivity increment	53%

4. Conclusion

The objective of this study was to map the existing process to find out non-value-added activities and alternative solutions which has been accomplished. The study can be carried out further by analyzing more alternatives and enlarging the observation period and parameters for the whole cutting processof each type of material. Also, some other VSM tools can be implemented such as Production variety funnel, Quality filter mapping, and decision point analysis, by integrating the back-and-forth sections of the business to eliminate non-value-added attributes from the system.

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