

## Importance of Holistic Approach of Assembly Production Transformation in Manufacturing with Value Stream Mapping

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In the current world, the business faces different challenges, as it was in the 1950<sup>th</sup>. Today, most of the manufacturing companies have a very strict approach to increasing market needs of Safety, Quality, Delivery and Cost key performance indicators (KPI). To stay competitive, it is needed, that a holistic approach on the improvement of strategic KPIs is needed in order to be successful. The target of this paper is to show the application of the Value stream mapping methodology, used in a case study for a finish good assembly line in an Electronic Manufacturing Facility. The study is showing the improvement of quality, delivery and productivity KPIs over a time period of 3 consecutive years. The result is the increase of production output from 500 pcs/shift to 1050 pcs/shift, decreasing the number of quality returns from 3 to 0 and improving the delivery performance from 95 to 100% against customer requested date.

**Keywords:** Manufacturing assembly line, Value stream mapping, Lean, SQDCI, KPI improvement, waste, EMS

### 1 Introduction

In the last 60 years, the methodology of Lean did change with the introduction of computers, more accurate KPI measurement methods, automation and digitization. However the methods of Lean manufacturing, as the solid foundation remained unchanged. So the state of art Value stream mapping, 5S and Standard Work methodologies are in principle the same, as in the age of Taichi Ohno, when the definition of lean thinking was defined very close to the definition by Kovacs (2017) as Lean thinking focuses on value-added flow and the efficiency of the overall system. The goal is to keep product flowing and add value as much as possible. The focus is on the overall system and synchronizing operations. [7]

The importance of the understanding of the base methodologies, putting the modern digital and automatic bolt-ons aside, is then determining the ultimate success of the implementation of result based improvement events in the operations, especially in the assembly business, where many manual and semiautomatic production steps are needed. Therefore a holistic approach to definition of value added operations and steps is needed. Womack describes holistic approach for search of the values in business as most producers want to make what they are already making and partly because many customers only know how to ask for some variant of that they are already getting. They simply start in the wrong place and end up at the wrong destination. Then, when providers or customers do decide to rethink value, they often fall back on simple formulas – lower cost, increased product variety through customization, instant delivery – rather than jointly analyzing value and challenging old definitions to see what's really needed. [1] So in the successful implementation of Lean methodologies of Value stream mapping, 5S, Standard Work and Lean Daily Management, the redefinition of value added processes and non-value added processes with a crossfunctional team of operators, engineers, buyers, technicians and customer representatives is needed. This principle is one of the few principles,

where companies mistakes and then have unsuccessful implementation and not enough or no results. Only the intellect of all employees can permit a company to live with the ups and downs and meet the requirements of its new environment. [3]

### 2 The methodology used in the case study

In this case study, the author has been using the Value stream mapping, the technological tool for the improvement of the understanding of the current situation of the processes and the process parameters as well as the understanding of the non-value added processes, that are influencing the key performance indicators of the various process steps. Further this tool is enabling to the team to create a desired future state that is reflecting the needs and the planned performance that is required by the customer. The gap analysis between current and future state are then giving the set of actions and lean tools that are to be used to come from the current state to the future state. The tool is described in the chapter 2.1

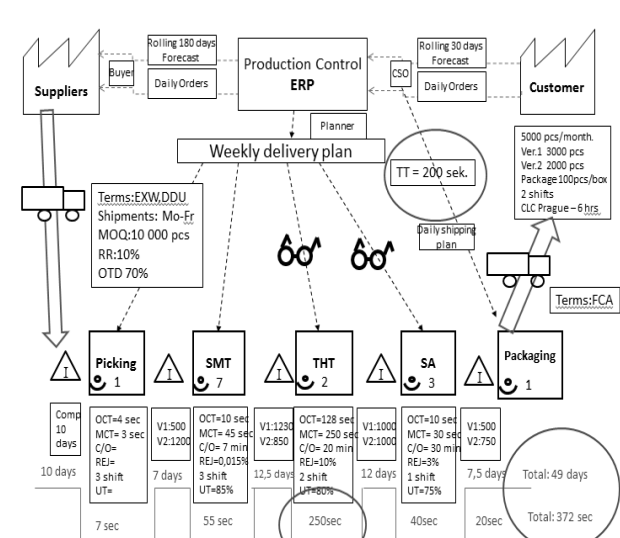


Fig. 1 Current state map example [5]

5S and Standard Work methodologies for the identification and transformation of the non-value added processes to value added processes or to the reduction of the non-value adding processes, on the production assembly line. Both methodologies are described in the chapters 2.2 and 2.3.

Lean Daily Management methodology is used for sustaining of the results with daily KPI reporting and problem solving, if processes are out of order. It is a highly valued tool among professionals, as it is reducing the amount of non-value added communication and gives a good base for problem solving. LDM is described in chapter 2.4.

And Problem Solving as the last of the methods with 5 Why, Ishikawa and brainstorming are the last of the methods used in this study with respect of getting back to track, when goals on daily, weekly or monthly bases were not reached. These tools are described in chapter 2.5.

### 3 Value stream mapping

Value stream mapping is a method that contains of several steps, that enables a cross-functional team of employees, to map the whole process related to the product, not only production itself. It contains of a current state process map, including the customer and supplier information, planning information of the whole supply chain, production steps including the warehouse processes and also all relevant KPIs for all above mentioned processes, incl. For example: inventory information, quality related information, process thru-put times and product lead times. The ultimate goal of Value stream mapping is not to make immediate change and improvements in the processes that are mapped; however it is in identifying and evaluating four elements. Value added and necessary processes, Value added and not necessary processes, Non-Value added and necessary processes and Non-Value added unnecessary processes from the current state map.

With this analysis and the target settings a future state is the drafted, where the four process statuses are evaluated and improved in theory. After the future state is done, the current and future step maps are compared and a gap action plan from current to future map is drafted.

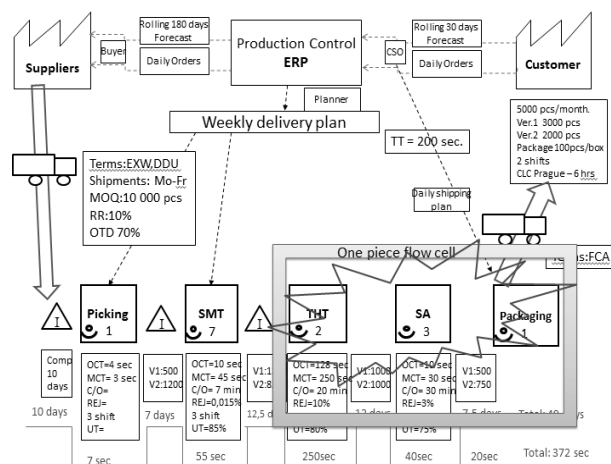


Fig. 2 Future state map example [5]

The critical point is reached and to have a successful

implementation of the future step a full support of resources from the management team and from customer, supply chain and employees is necessary.

### 4 5S

5S methodology is a Japanese based concept first brought by the team of Toyota based manager Taichi Ohno. The main purpose of 5S is to promote process visibility, that is, to make kaizen opportunities instantly obvious [4]



Fig. 3 5S explanation in one page [5]

The importance of 5S in assembly technology is, that is it a system enabling the associate or machine to have: the right tools, in the right quality and quantity, at the correct place and in needed time for most efficient work, and makes sure, that at changing of the status of the process, all the necessary steps are being taken, to repeat the analysis and repeat the above mentioned criteria implementation

Importance of the right system set up of 5S is, that it is then predicting well the costs that are forecasted for the maintenance of the workplace and tools, for a better budget utilization and planned maintenance, rather than reactive maintenance at a breakdown situation.

### 5 Standard work

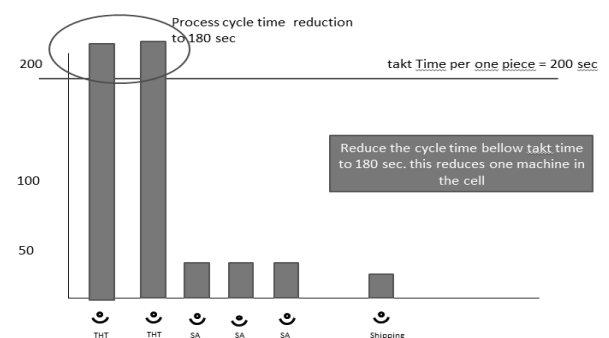


Fig. 4 Example of standard work balancing towards takt time [5]

Standard work is another of the used main Lean methods in the case study. The main purpose is, to make a system in the assembly line for:

Repetitiveness of operations inside the production line by different operators

Repetitiveness of operations between the shifts

Correct work balance of the operators and machines in order to achieve lowest throughput times

Correct production resources set up for the current customer ordering patterns

In the standard work methodology the emphasis needs to be given on analyzing the above mentioned points and with 5S and measuring of each step prepare a new layout of the production line in order to change the workplace to the needs of the safety of the employees and operations process driven by quality requirements, delivery business model and cost key performance indicators.

It is also critical, that the measurement is being done by the operators of the line in order to secure the measurement of all process steps

Another element, that is being used in various Standard Work events, however also alone, is a method called SMED. As Tamás (2017) is defining, this method enables the reduction of the changeover times, consequently also reducing changeover wastes (work in process (WIP), inflexibility, capital cost, etc.). This method tries to reach the single-digit minute exchange of dies. [6] Also elements of this method have been used in this study.

Another of the elements, that is widely used as a part of standard work is heijunka. Tamás (2017) defines, that heijunka means production levelling. The manufacturing of the products is realised on the basis of takt time as well as the amount and type of the products to be manufactured being distributed evenly throughout the examined period. This was also a part of the production planning thinking in the kaizen. [6]

## 6 Lean Daily Management (LDM)

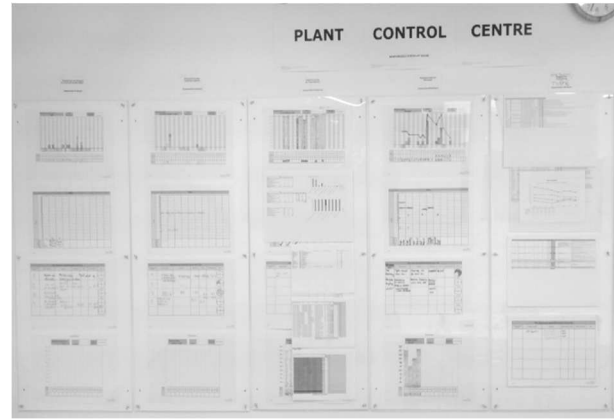
LDM is a management method that is based on Glass wall management principle that indicates open communication throughout the company. It contains steps from sharing key management information displaying the process sheets, or from posting the sample products to showing recent customer return at the shop floor – good or bad, all relevant information was shared so that everybody understood the situation. [3]

The key principle is to have following systems of communication and review in place:

- KPI Board with
  - Run chart for current situation update on a time based principle (online, hourly, per shift, day, week, month)
  - Pareto chart with the current data of all deviations from standard
  - 5Why and action plan section for identifying the root cause and countermeasures of the deviations
  - Trend line section on a time based principle (commonly used principle is

weekly or monthly KPI summary to see the longer term trend of the KPI behavior)

- Kaizen or Continuous improvement section with the upcoming or running action plan implementations important for the assembly or operations line



**Fig. 5** Example of Plant level KPI Board [5]

- Ownership and team structure for the review of the board with
  - Defined review team of owner and support functions needed for problem solving
  - Defined and agreed substitutes, in case of owner not present
  - Time schedule of KPI filling and Time schedule of problem solving review
  - Culture of sacred time for the review. In this culture, no other meetings can be planned into the LDM review time
- Level review agenda with
  - Cell level review with the operators and team leader
  - Department level with team leaders, support functions and supervisor
  - Production level (if needed for companies over 1000 employees) with support functions and production leaders
  - General/Plant manager meeting with the plant support functions

With this system set up, and deviations in the process from safety, quality, delivery or cost targets are identified, root causes are determined and countermeasured with a follow up action plan.

## 7 Case study

The case study has been done in term of 3 years in one of the world leading EMS companies on a customer line

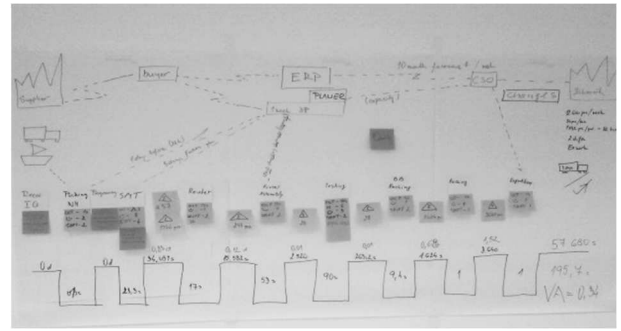
of a world leader in the segment. There were 3 major improvement campaigns started in 2014, 2015 and 2016 for improving various KPIs. The targets are in section 7 and following those, in section 8 to 10 the author is showing the results of sustainable step improvements over the followed period. All results have been also reviewed and acknowledged by the local management team and general manager of the site.

## 8 Target

- Year 2014: Improve the supply ability of the production by:
  - Pieces per shift output: 1050 pcs/shift production
  - On time delivery performance: 100%
  - Ability to add more than 2 product variants into the production line
  - Improving ergonomic and working environment of the operators
  - Creating a new planning system for easier handling of work orders by the planer
- Year 2015: Improve the supply ability of the production by:
  - Pieces per shift output: 1440 pcs/shift production
  - On time delivery performance: 100% (added 7 more variants)
  - Further improving ergonomic and working environment of the operators
- Year 2016: Improve the supply ability of the production by:
  - Implementing Kanban system between SMT and Box Build Line

## 9 Overview current and future state 2014

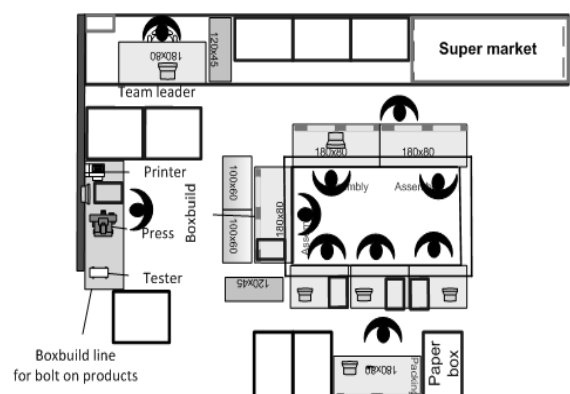
- Current state
  - Number of operators: 6 per shift box build
  - Number of pieces produced per shift: 500 pieces
  - Productivity (pieces/operator/hour): 11 pcs/op/hr
  - Productivity per m<sup>2</sup>: 9 pcs/m<sup>2</sup>
  - On time delivery 77 %
  - Batch production
  - sitting operations, very narrow corridors
  - no 5S elements visible
  - material feed by the line operators



**Fig. 6** Current state map for the case study

- Future state
  - Number of operators: 6 per shift box build
  - Number of pieces produced per shift: 1050 pieces
  - Productivity (pieces/operator/hour): 23,3 pcs
  - On time delivery 100%
  - One piece flow implemented
  - Implemented sitting and standing operation combination,
  - Implemented material handler
  - Implemented standing and sitting tables by STN norms for ergonomic
  - Implemented 1-4 S from 5S initiative implemented
  - Material feed from outside into the cell
  - Implemented Lean Daily Management Board and process of reviews of KPIs
- Improvement ratio:
  - Productivity: 112 % improvement\*
  - On time delivery 23 percentage points improvement\*
  - Output pcs/shift 110 % improvement\*

\* ratio of improvement is calculated to the current state at the begin of the improvement activity in 2014



**Fig. 7** New one piece flow layout

## 10 Overview future state 2015

- Number of operators: 8 per shift box build
- Number of pieces produced per shift: 1440 pieces
- Productivity (pieces/operator/hour): 24 pcs
- On time delivery 100%
- Improved cell layout implemented

Improvement ratio:

- Productivity: 3 % improvement\*\*
- Output pcs/shift 37 % improvement\*\*
- On time delivery 23 perceptual points improvement\*\*

\*\* ratio of improvement is calculated on base of the future state after the first improvement activity in 2014

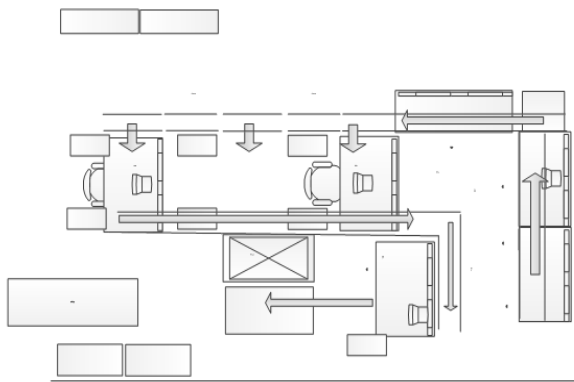


Fig. 8 improved one piece flow layout 2015

## 11 Future state 2016

- Space in m2: 23m2
- Additional savings cycle time and handling costs: 1% saving against FY 2016 costs of goods sold
- Implemented new kanban system
- Implemented new handling system for testers

- Implemented new station for short time programming

Improvement ratio:

- Space: 15 % improvement\*\*\*

\*\*\* ratio of improvement is calculated on base of the future state after the second improvement activity in 2015

## 12 Conclusion

The case study has clearly showed, that despite improvements that are in case of productivity showing more than 100% of the previous state, with Value stream mapping approach the EMS company team was able to identify year after year for 2014-2016 additional improvements and savings in various parts of the operations for the particular project.

## References

- [1] J.P. WOMACK, D.T. JONES (2003). *Lean Thinking*, 2003, Page 11
- [2] M. IMAI (2004). *KAIZEN, The key to Japan's Competitive success*, Computer press, Vol. 1 2004, p. 412-418.
- [3] K. SUZAKI (1993). *The New Shop Floor Management: Empowering People for Continuous Improvement*, The Free Press, 1993, Pages 5, 78, 79
- [4] J. NAKANE, R. W. HALL, Ohno's Method : Creating a survival work culture., Association of manufacturing excellence, Website article
- [5] M. SAGAN Value stream mapping, 5S, Standard work, Internal training material, Enics Group
- [6] P. TAMÁS (2017). Examining the possibilities for efficiency improvement of SMED method using simulation modelling, *MANUFACTURING TECHNOLOGY* 17: 120-126. (2017)
- [7] G. KOVÁCS (2017). Productivity Improvement of Assembly Lines by Lean Methods, *MANUFACTURING TECHNOLOGY* 17: 192-197 (2017)