Sihn/Kuhlang [Ed.]

Sustainable Production and Logistics in Global Networks

43rd CIRP International Conference
on Manufacturing Systems
26 – 28 May 2010, Vienna

Proceedings

Fraunhofer

TECHNISCHE
UNIVERSITÄT
WIEN
Vienna University of Technology

nwv neuer wissenschaftlicher Verlag

TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Fraunhofer

PROCEEDINGS

International Conference on Manufacturing Systems

Organised by

Vienna University of Technology
Institute of Management Science
Division Production Engineering and System Planning

Fraunhofer Austria Research GmbH
Division Production and Logistics Management
www.fraunhofer.at / office@fraunhofer.at

Editors:

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nw neuer wissenschaftlicher Verlag
TECHNIK
Vienna · Graz 2010

Bibliographic information published by the Deutsche Nationalbibliothek

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at http://dnb.d-nb.de.

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ISBN 978-3-7083-0686-5
Neuer Wissenschaftlicher Verlag GmbH Nfg KG
Argentinierstraße 42/6, 1040 Wien
Phone: +43 1 535 61 03-24, Fax: +43 1 535 61 03-25
e-mail: office@nwv.at

Geidorfgürtel 20, 8010 Graz
e-mail: office@nwv.at

Internet: www.nwv.at

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Druck: Széchenyi István Nyomda Kft., Győr (HU)

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Value Stream Mapping for the Optimization of Maintenance Processes

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Abstract

In this paper, two new developed methods are combined for the optimization of maintenance processes. The first method is the development of a standard for the sequence of process steps in the implementation of various maintenance tasks.

Due to standardization, key indicators can be collected, which can be applied to individual process steps in order to make comparisons with other maintenance areas. With this logical design, key figures can be generated very simple. Areas of improvement are getting visible and the process standard is a good basis for new employees.

The method Value Stream Mapping was adapted for analysis and optimization of maintenance processes. Shorter lead times and more effective maintenance processes are the result. The advantage of the tool (one page mapping) is, to see the whole value stream of maintenance. Decisions can be based on facts with the focus on the customer that is the production shop floor.

Keywords:

Maintenance, Standardisation of processes, Value stream mapping

1 INTRODUCTION

In times where companies are exposed to global competition, it is necessary to locate, and if possible eliminate wastes in processes along the supply chain, to obtain a high flexibility in production or service generation. The presumably best-known example is the "Toyota Production System". In the past decades, these Japanese methods were implemented successfully in western companies and were adapted successfully to other areas with the target to create a "Lean Business System".

One of these areas is maintenance that has the image as cost driver, but with the modern manufacturing systems with reduced inventory, short production lead times, the emphasis on equipment availability has become

even more critical in order for the companies to successfully implement and sustain Lean principles [1].

When equipment breaks down in a lean manufacturing system, the entire production line is shut down, until the equipment is brought back to its normal working condition. Therefore high amount of non-value added time between machine stoppage and completion of repair, compounds the production loss.

The purpose of this paper is to provide a new view on maintenance processes and to develop a process standard, with which it is possible to describe maintenance in a transparent way and to evaluate the non-value added activities. A value stream map, developed specifically for maintenance helps to reduce the Maintenance Lead Time and to create lean maintenance processes.

2 DEVELOPMENT OF A PROCESS STANDARD FOR MAINTENANCE

The first method is the development of a standard for the sequence of process steps in the implementation of various maintenance tasks. This standard makes it easy to understand the logical structure of maintenance processes and allows a uniform approach when planning and executing different maintenance tasks.

Due to standardization, key indicators can be collected, which can be applied to individual process steps in order to make comparisons with other maintenance areas. The important key indicator "Mean time to repair" (MTTR) is clearly visible.

By extending the representation with Event-driven Process Chains (EPC) – from the next higher detail level – Interfaces and responsibilities with possible improvement potential become evident.

An overview of the process standard environment is shown in figure 1.

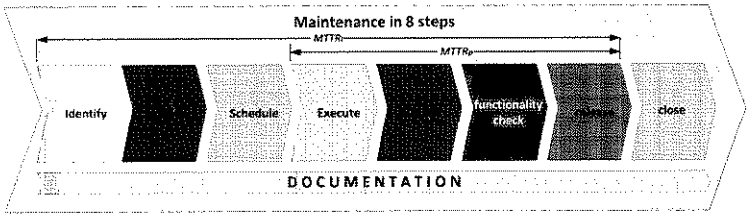

Figure 1: Maintenance in eight steps [2]

The process environment consists of eight steps: Identify, plan, schedule, execute, restart, functionality check, release, close and documentation as supporting process. In the following, the eight process steps are described from their starting to the final event. It should be noted that the implementation rate of the respective process steps depends on the complexity of the maintenance tasks and of the importance of the system that has to be maintained.

Identify

The starting event of this process step is either a failure or a planned maintenance activity. If the starting event is a failure, this process step is the starting time of the key figure "Mean Time to Repair" (MTTR). For optimal planning and execution, all necessary information need to be collected and appropriate activities need to be set. The end event of this activity is "*Known activities which can be accomplished*" that is as well the starting event of the next process step.

Plan

With the information of the first step, personnel, material, equipment and execution date is scheduled. With the execution date, the process planning is finished. The end event of this activity is: *Readily planned work order.*

Schedule

In this process step, planned resources like material, equipment, tools and spare parts are prepared and obstructive parts are disassembled so that the maintenance can be performed unhindered. If the system is ready for the actual maintenance activity, the schedule is completed. That is also the end event of this step.

Execute

In this step the planned activities from the work order (planned maintenance activity), or the activity derived from the process step "Identify" is processed. Execution is the only step seen as a value added process. The end event of this step is: *Planned maintenance activities finished*

Restart

The restarting operation contains the evaluation of system engineering, building services and safety related components as well as the actual start-up of maintenance objects. Operable equipment is the end event of this step.

Functionality Check

In this process step, the performed actions are evaluated based on quality standards. The results are recorded in a supplied maintenance-document. The end event could be either "Functionality Check passed" or "functionality check not passed".

Approval

With the approval, the maintenance object is passed back to the user's responsibility. The MTTR ends with this process step. The end event can be "approved" or "not approved".

Close

The last process step contains reporting (employees/departments), logging (validation protocol), returning and disposing of the commodities and finally closing of the work orders. Also, deduce future activities and updating the maintenance plans as result from the finished maintenance activities need to be assigned to this process step.

3 LEAN MAINTENANCE BY VALUE STREAM MAPPING FOR MAINTENANCE TASKS

A *Lean Maintenance System* is a concept that combines the approved approaches and principles of Lean Thinking with the modern versatile concepts and tools of maintenance, with the central goal, avoiding waste.

With the adaptation of value stream mapping for the maintenance area the value creation process of maintenance becomes visible. This is important for production purposes, since maintenance processes are not seen as value added processes.

This new developed method is based on the new developed standardized process "maintenance in eight Steps" and is sub-divided into 4 phases:

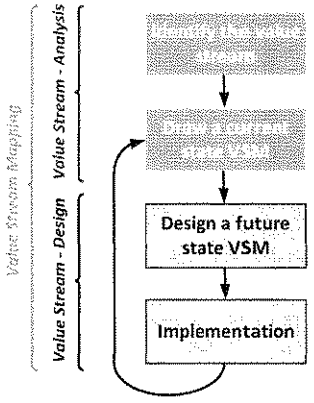

Figure 2: 4 Phases of Value stream mapping [2]

3.1 Selection of the value stream

The first step is a reasonable categorization from the different maintenance tasks (for example corrective or preventive maintenance tasks, failure, repairing, planned maintenance) in order to receive a meaningful value stream mapping. Due to highly different tasks in the maintenance area, this is essential and needs to be done carefully [3].

The realization grade of the individual process steps within the "maintenance in eight steps" model depends significant on the time available, complexity, closeness to production and the task itself.

3.2 Draw a current state value stream map

After selecting the value stream, the process chain is outlined as an extended event-driven process chain [2] (eEPC) as shown in figure 3.

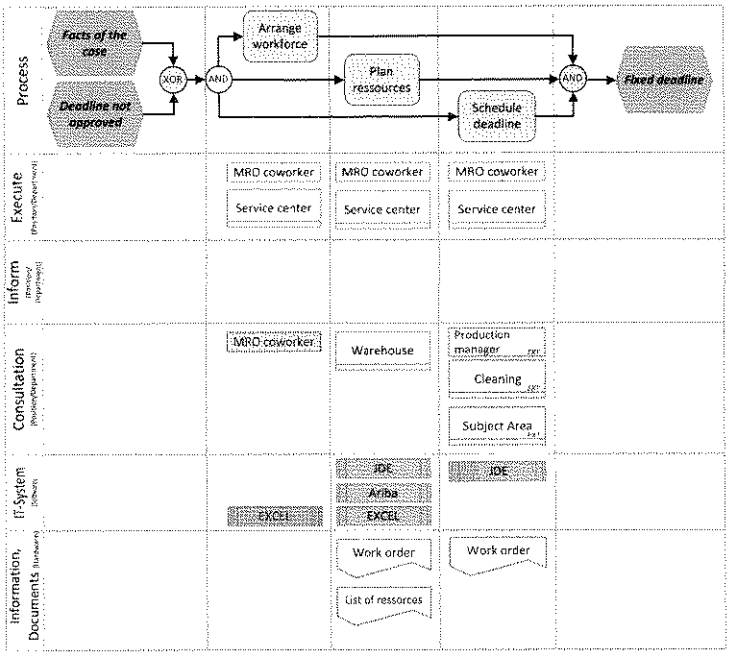

Figure 3: eEPC of the second process step: *Plan*

In order to acquire the information, a custom-made data acquisition sheet is created, which is accompanied with the selected category of the maintenance task and evaluated afterwards.

3.3 Additional symbols for maintenance processes

By using VSM for maintenance processes, a company gains the advantage of a common language [4]. By assigning clear symbols to the individual process steps, this process is supported even more (figure 4).

Identify: The process chain is started		*Restart*: Restarting and reassembling of the unit.	
Plan: Measures are derived and planned		*Functionality check*: Check the functioning of the unit.	
Schedule: Planned resources are "packed" in this step.		*Release*: Handover of the unit to the user.	
Execute: Tools and equipment are used for maintenance.		*Close*: Maintenance task is completed.	

Figure 4: Symbols for the maintenance VSM [2]

3.4 Procedure of creating a maintenance value stream

A maintenance value stream can be created in eight steps:

1. Description of the relationship between the customer and the eight steps of the maintenance process.
2. The eight process steps are extended by data frames and process parameters from data recording, e.g. transition time, process step cycle time or process lead time.
3. Analysis and documentation of the interfaces to resources like documents and the EDP system (What kind of EDP system or documents are used?).
4. Detection of the transition time between the process steps
5. If data that should be already known from previous process steps need to be collected, a loop from the present process step to the incorrectly executed process step needs to be drawn in.
6. Control and transition - How are the process steps organized, how does the connection between the process steps look like and how are the work orders processed? (PUSH, PULL, FIFO)
7. Underneath the developed scheme, a timeline is drawn that shows the transition times, process step cycle times and process lead times.
8. Possible Improvements will be outlined by KAIZEN-Flashes as the last step of the VSM analysis

3.5 Creation of the target state

At this stage of the VSM method on basis of the value stream analysis, under consideration of the area of influences and principles of the VSM a target state for the maintenance process is created.

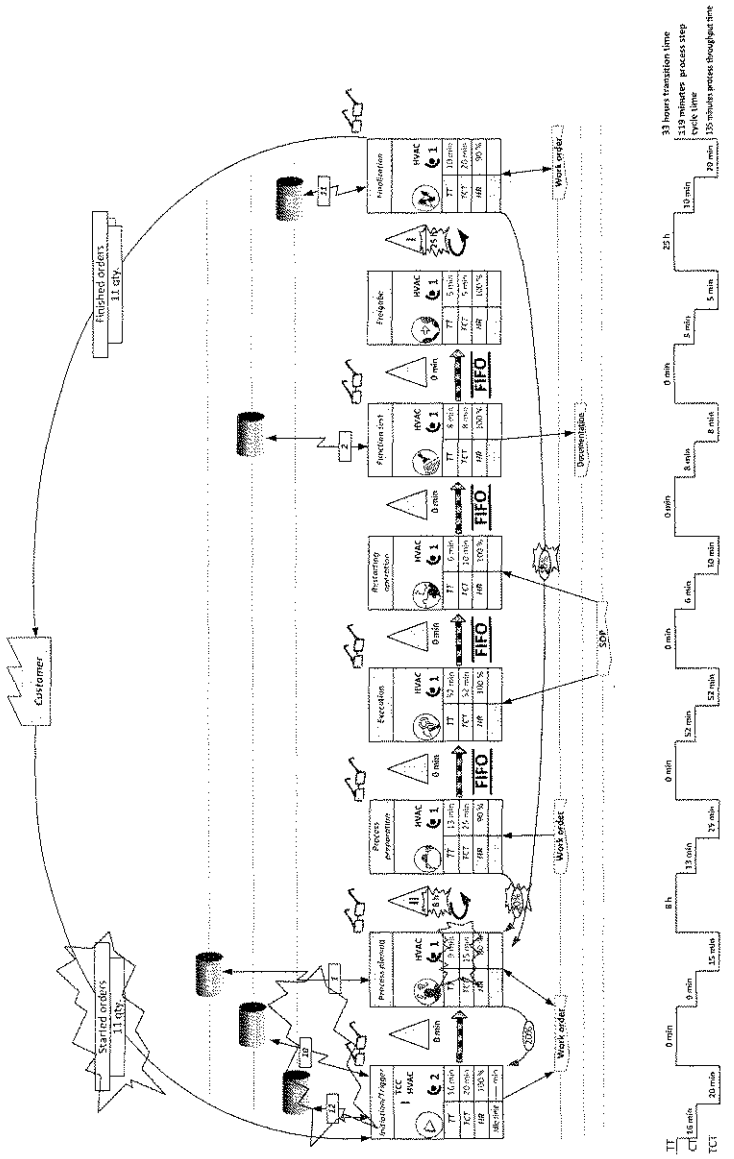

Figure 5: VSM analysis for a maintenance process

The following considerations need to be included for a target state conception:

Customer requirement

What are the requirements in terms of quantity and quality from the customer to the value stream?

Classification of the process step

Which work steps need to be set and how should they be initiated? For this question, the process cycle is analyzed and categorized based on the eight step maintenance.

Where can continuous flow be used?

The process steps need to be processed successively, without interruption. Thus, it comes to a reduction of interface losses, shortened transport and idle time etc.

Pull-System

In case it is not possible to integrate a continuous flow between the process steps, a Pull-System can be used to connect the process steps with each other.

Process improvement

In which stages of work are large differences between cycle time and lead time?

Flexibility

Is it possible to adjust the extent of work of planned maintenance (e.g. by splitting tasks) to be more flexible if there is a failure?

Work content

Ideally, the process steps of the value stream are handled by one single maintenance employee at a draught.

Implementation projects

After critically analyzing the actual state with consideration of the six areas of influences, the outcome is the nominal state, which needs to be developed in the fourth phase.

To be able to realize the target state a good designed and consequent project management is needed. The project teams need the according power and capacities. These are described in the VSM one year plan. Constant supervising and survey of advance and intended goals is necessarily for a successful realization. This is done by project monitoring reviews.

4 SUMMARY

The method Value Stream Design is a simple tool for one page mapping and for seeing the whole. Decisions can be based on facts and figures and the material- and information flow is becoming transparent.

The standardization of maintenance processes and the adaptation of the Value Stream Mapping method for maintenance procedures contribute to

the reduction of lead-time of maintenance processes and therefore contribute to the increase of availability of machines and assets.

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