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# Sustainable Production and Logistics in Global Networks

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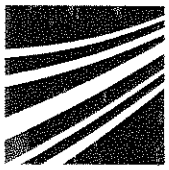

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# A new methodical approach to increase productivity in production-logistical processes

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**Abstract**

The introduced methodical approach connects Value Stream Mapping (VSM) and Methods-Time Measurement (MTM) and offers new distinct advantages to reduce lead time and increase productivity based on lean principles and standardised processes. The mutually aligned design and improvement of assembly and (production) logistic processes takes either the workplaces, their surroundings and the supply areas as well as the overall value chain into account. The identification and exploitation of productivity potentials is realised by the joint application of VSM and MTM focussing the (work) methods, the performance and the utilisation of the processes (the dimensions of productivity).

Principles, benefits and the procedure of application are described in the paper.

**Keywords:**

Productivity, Logistics, Standardisation of processes (Value Stream Mapping, MTM)

## 1 INTRODUCTION

Increasing productivity in a defined time frame (e.g. shift), among other things, causes the increase in overall added value within this defined time frame. A short lead time through a process chain (a value stream) results in a higher output therefore in higher productivity and thus increases the overall added value within a given period of time. Lead time reduction in a value chain arises from reducing lead times (operating times, idle times, transportation times...) of the sub processes in this value chain. The target for designing a process is therefore to create its added value as fast as possible. Based on this "faster" processes "more" time is available in a given period of time to "produce" more output.

## 2 VALUE STREAM MAPPING AND METHODS-TIME MEASUREMENT AT A GLANCE

A value stream includes all activities, i.e. value-adding, non-value-adding and supporting activities that are necessary to create a product (or to

render a service) and to make this available to the customer. This includes the operational processes, the flow of material between the processes, all control and steering activities and also the flow of information. Taking a value stream view means considering the general picture of an organisation and not just individual aspects. Value Stream Mapping was originally developed as a method within the Toyota's Production System and is an essential element of Lean Management. It was first introduced as an independent methodology by Mike Rother and John Shook. Value Stream Mapping is a simple, yet very effective, method to gain a holistic overview of the status of the value streams in an organisation. Based on this picture flow-oriented value streams are planned and implemented. In order to assess possible improvement potential, Value Stream Mapping considers, in particular, the entire operating time compared with the overall lead time. The greater the distinction between operating and lead time the higher the improvement potential [1].

MTM is the abbreviation for Methods-Time Measurement, meaning that the time required to execute a particular activity depends on the method performed for this activity. It is a modern instrument to describe, structure, design and plan work systems by means of defined process building blocks. MTM exhibits an internationally valid performance standard for manual tasks. Today, MTM is the most common predetermined time system in the world, thus establishing a worldwide uniform standard of planning and performance for a global business.

A process building block represents a process step with a defined work content and a distinct purpose for which a standard time applies. A system of process building blocks consists of a defined amount of process building blocks. A MTM system of process building blocks [2] was developed for a specific, clearly defined process typology, a specific complexity of processes and defined process characteristics. MTM process building block systems are assigned to clearly defined fields of application such as, mass production, batch production or job shop production. The most important MTM process building block systems are the basic MTM-1 system, the higher level UAS (Universal Analysing System) and MEK (MTM for one of a kind and job shop production system). MTM process building block systems provide a formal descriptive language for processes, are used uniformly throughout the world and are keen on recognizing the relevant influencing factors in a process. The use of MTM provides a valid base for the evaluation of productivity, time based information to plan and control processes and supports the identification of deficiencies within the organisation.

A value stream analysis provides a very fast overview of the whole value stream from the supplier to the customer, with the focus on lead time and linkage between the processes. MTM is a tool based on a uniform process language to describe and standardise processes. In addition it provides the time (basic time) of the single processes in the value stream.

Value Stream Mapping and MTM aim at identifying, evaluating, reducing and eliminating waste within the value stream in terms of Lean Management.

## 3 LEAD TIME

Viewed at a high abstract level the lead time is that period of time (hours, minutes,...) required by any process to transform the inputs (materials, customers, money, information) into outputs (goods, services). A precondition for determining lead time is the specification of measuring points. In a work system or chain of processes idle time following processing and transport is allocated to the subsequent workplace or subsequent process. The five elements idle time before processing, transport, idle time after processing, set-up and processing determine the lead time of a process [1].

According to Little's Law, the extent of inventory reveals a lot about the lead time. The extent of inventory, more or less, corresponds to the idle and/or transport times. In general terms, the lead time consists of operating and process times as well as of idle, transport and set-up times (see equation 1).

A value stream's lead time results from the sum of all operating, process and set-up times of the processes, as well as, the extent of the various inventories [3].

$$LT = \sum_i (OT + PT + ST) + \sum_j IR = \sum_i (OT + PT + ST) + \sum_j (IT + TT) \quad (1)$$

LT ...lead time (of a specific value stream)

OT ...operating (processing) time

PT ...process time

ST ...set-up time

IT ...idle time

TT ...transport time

IR ...inventory range

i ...no. of processes

j ...no. of different "work in progress"/inventories

## 4 PRODUCTIVITY

Productivity is the expression of the quantitative productiveness of an economic activity (of the product realisation process) and allows conclusions to be considered how well the production factors deployed are used. Productivity is defined as output divided by the input factors. Basically, productivity is differentiated according to the individual production factors (work, machinery, material).

On the one hand, productivity increase results from increases in effectiveness by eliminating what is wrong and/or from doing what is right and on the other hand from increases in efficiency, through accurate assessment and the achievement of levels of capacity and performance. A consideration of the different dimensions of productivity provides a profound understanding of this relationship and a basis for measures to increase productivity [4].

The dimension "method" describes "how" a work assignment or work content in a specified work system is fulfilled and refers to the whole process chain (overall processes), as well as, to single processes or executions.

The dimension of "utilisation" considers aspects of the degree to which resources are utilised. The "performance" dimension considers aspects of performance level (willingness to perform, achievement potential).

## 5 INCREASING PRODUCTIVITY USING VALUE STREAM MAPPING AND MTM

The design of (work) methods is the most important dimension for influencing productivity [4], [5]. Planning and implementing "well" designed, i.e. efficient and effective methods are at the very focus of projects to increase productivity (see Figure 1).

These projects can lead to investment. The achievement of high employee utilisation, however, does not often require investment. Obstacles, such as fluctuations in customer or order-frequency, without flexible employee assignments lead to utilisation losses. This can frequently be recognised in service processes (e.g. trade, administration). The time determination of processes e.g. in production areas to evaluate the performance level opposes these obstacles efficiently. In particular a neutral and valid base to evaluate performance is required to achieve increases in productivity.

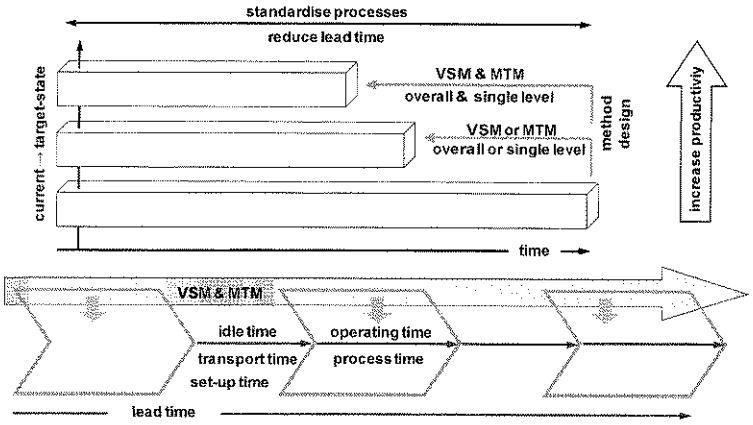


Figure 1: Method design by VSM and MTM [6]

Table 1 exemplary provides an overview of the different design areas for the dimension (work) method, performance and utilisation. Value Stream Mapping does not just contribute to reducing lead times by reducing and avoiding waste, it also contributes to increasing effectiveness and efficiency by improving work methods and the organisation of work, thereby raising productivity.

The focus of optimisation is the alignment and combination of individual processes to form a continuous, efficient value stream throughout the organisation (consideration of overall processes). Through its well-grounded time determination and with its systematic analysis of processes, MTM contributes to evaluation and productivity improvement. The focus of optimisation are the individual activities and work places (consid-

eration of single processes). MTM contributes to determine and assess the performance level correctly. Capacity utilisation is influenced by both MTM and Value Stream Mapping. The two tools complement each other perfectly in contributing to raising productivity as the combined application of Value Stream Mapping and MTM affects the design of all three dimensions of productivity.

Looking at the dimensions and their design areas (see Table 1) it becomes obvious that the increase of productivity is achieved by designing smarter processes combined with reduced investment and low cost automation. The focus is set on designing methods (processes) and standardising work. The different aspects of the design areas indicate to possible potentials for improvement.

| **Method / process design** | |
|---|---|
| **"Single processes" (indiv. task-orientation) - MTM**<br>• layout - workplace design (tools, fixtures, machines…)<br>• added value, complimentary work, waste<br>• handling expenditures<br>• expenditures for controlling and supervision<br>• ease of assembly/ disassembly<br>• ease of grasp/operability<br>• manual material handling | **"Overall processes" (flow-orientation) - VSM**<br>• process organization / work organization<br>• production systems<br>• layout - workplace alignment layout (factory, floor, assembly line, cell…)<br>• material flow |
| **"Information and control" - VSM+MTM**<br>• production planning and control<br>• control principles | <br>• product design<br>• design of information flow |

| **Performance** | **Utilisation** |
|---|---|
| **MTM**<br>• performance standards (performance rate, actual / target-time ratio, standard time, normal performance, …)<br>• personal performance<br>• labor standards<br>• training, routine<br>• motivation/disposition<br>• target orientation / monitoring<br>• competences, skills, education<br>• support / instructions, coaching | **VSM+MTM**<br>• net man-hours worked, total amount of hours available<br>• fluctuations in order-frequency and work content<br>• balancing (static, dynamic)<br>• work in progress / inventory<br>• stock (amount)<br>• idle times / breakdowns<br>• scrap (quality of work)<br>• setup times / change over efficiency<br>• maintenance<br>• machine utilization<br>• material utilization<br>• area utilization |

Table 1: Dimensions of productivity – design areas [6], [7]

## 6 ASSESSMENT OF LOGISTIC PROCESSES

The extended value stream (see Figure 2) is taking logistic aspects, such as transportation distances and transportation vehicles especially the resulting transportation times, into account. It applies lean principles (e.g. avoiding waste, applying pull-principles) in order to steer the transformation and the design of new logistic processes. Due to the fact that quantitative assessment possibilities are often neither available in the present nor in the target status, an assessment of the intended changes in the processes is very often impossible. VSM as a method is not providing a reliable and retraceable procedure to timely estimate time-aspects of transportation distances or manual material handling (e.g. box handling in supply areas).

By applying MTM process building blocks "logistics" these essential pieces of information can be indentified/calculated on a reliable, standardised and retraceable base in the current status as well as in the target status. Particularly during planning future processes quantitative evidence about the target logistic efforts (such as transportation times, utilisation of internal logistic staff) can be estimated.

Applying MTM valuably contributes to the organisation, the design and the evaluation of logistic processes. Logistic issues in different areas of companies are characterised by comparable procedures with a significant level of repetitiveness.

Typical logistical procedures have been standardised and condensed into a process block system. It provides standards for the following logistical processes [8]:

- Transportation (procedures with different transportation vehicles such as forklifts, electric forklifts, manual lift trucks, trolleys)
- Manual handling (of cardboard boxes, containers, barrels of boxes, opening and closing of wrappings/packings, information processing (orders/receipts))
- Process blocks are also available for commissioning tasks.

The arising necessity in a VSM analysis to evaluate the required logistic efforts, it is highly recommended to enlarge the classical VSM by additional logistical aspects and subsequently gain a more convincing and concise holistic picture which provides a sound base for the evaluation procedure. This "extended" value stream extends "classical" value stream data (such as operating time and lead time) by information regarding required inventory, supply and production areas as well as by information about means of transportation, distances and times (see Figure 2).

From a logistical point of view MTM expands VSM by the aspect of established time assessment. Special attention must be drawn to the fact that the logistic planning of transportation using different means of transport between stock and workplace can be achieved in both the current and target status. MTM process blocks attain special importance to calculate / by calculation box handling between means of transportation and supply areas (e.g. supermarket-racks, flow racks) and further onto the workplaces.

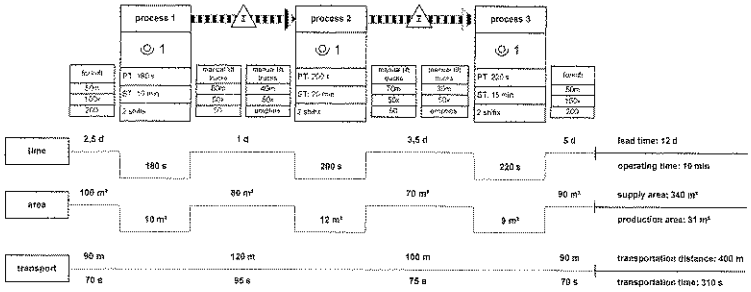


Figure 2: Extended value stream

The joint application of VSM and MTM creates new ideas for designing and implementing (assembly) workplaces, the surroundings, the supply areas and the transportation flow (see Figure 3):

- Planning and practical realisation of a u-shaped assembly workplace supplied by material in an e-Kanban system (pull-principle)
- Balancing the processes within the assembly workplace and defining transfer and decoupling points between the workplaces in the assembly cell.
- Planning of transportation tracks, its distances and subsequently its transport efforts based on MTM process blocks "logistics" in order to be able to calculate the utilisation of the internal logistic staff.
- Quantification of the required volume of manual filling of containers/boxes and handling of containers/boxes in the target status in-between different racks (e.g. in-between supermarket-racks and workplaces) also based on MTM process blocks "logistics".
- Implementing the "Double Piece Flow"-principles by applying suitable fixtures that ensure usage of both hands.
- Ergonomic design of workplaces (e.g. in height-adjustable work benches, grasp boxes in ergonomic reach distances, body postures, overhead work).

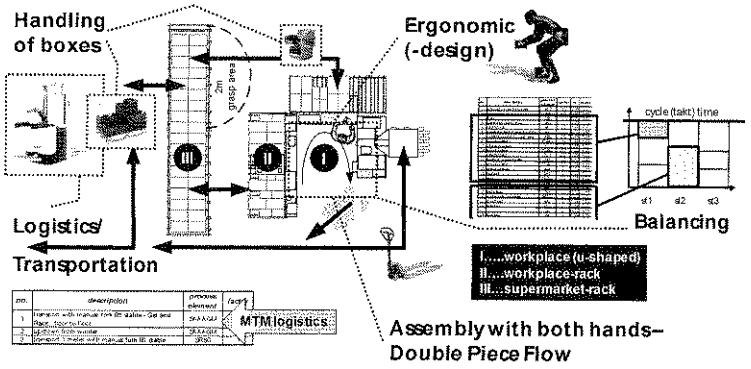


Figure 3: Layout of a workplace, surroundings, supply areas and transportation flow considering the new design ideas

## 7 PROCEDURE TO COMBINE VSM AND MTM

MTM contributes significantly in all different phases of VSM (see Figure 4). Proposals and ideas to improve the value stream are revealed by visualising and analysing the overall process and the single process. Those proposals are presented in so-called "Kaizen flashes". Approaches such as method- and workplace-design, work alignment (balancing), application of pull- (Kanban) and flow-principles (FIFO, One Piece Flow) are taken into consideration to create measures to implement the improvement proposals and to develop a target-status, respectively an ideal-concept. Finally "flow-orientated" and "individual task-orientated" improvement actions are gradually implemented (see Figure 5).

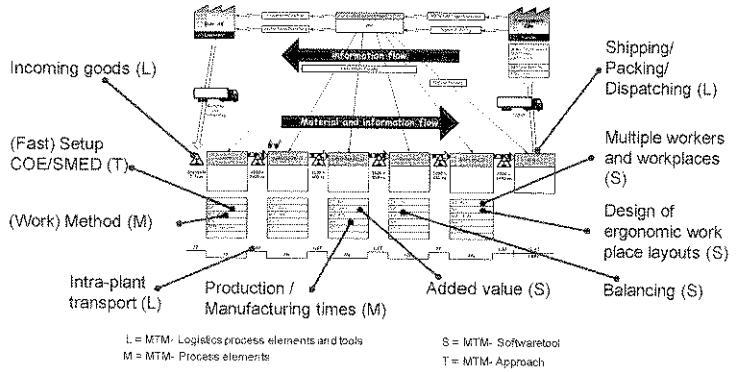


Figure 4: VSM amendment by MTM

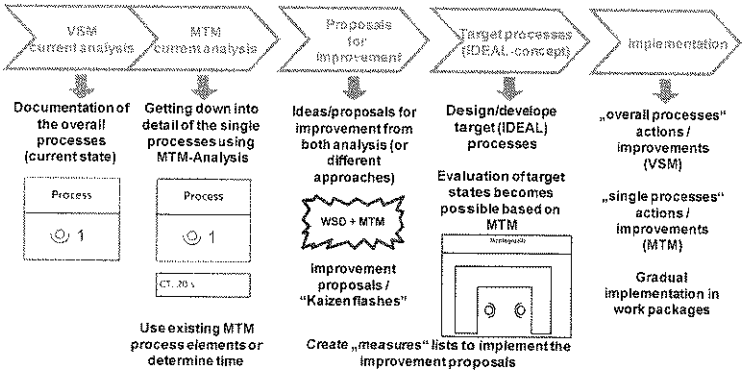


Figure 5: Procedure to combine VSM and MTM

## 8 SUMMARY

The interaction of Value Stream Mapping and MTM (the so-called Hybrid Optimisation of Added Value) at different levels of detail consideration, contributes to the identification, elimination and avoidance of waste and

thus leads to the design of efficient and effective processes. The joint mutual benefit of the combined application arises from the increase in productivity, from the standardisation of processes, from the reduction in lead time/inventory and from the accurately determined times; it also enables and ensures the predictability and the capability to assess the target status.

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