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Positions of MTM ASSOCIATION e. V. on change of the use and application of MTM process building block systems

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Foreword

Peter Kuhlang

Dear reader!

This 14th edition of the series "MTM-Schriften Industrial Engineerring" is a position paper which presents the views and explanations of the ASSOCIATION e. V. (MTMA) on the future use – more specifically on the further development of the use and application – of MTM process building block systems in the context of changing work systems in industrial companies. It also highlights the importance of MTM-HWD as a core element of digitization and virtualization, of "Approved by MTM" and of MTM simulation analysis for processing digitally generated motion data.

Among the most important tasks defined in the founding document of the MTM Institute are the development of MTM for the permanent expansion of MTM application, the creation of networks and the improvement of application requirements as well as public relations work for the (industrial) scientific discourse and broad (popular) scientific impact. Based on this tradition, the publication series "MTM-Schriften Industrial Engineering" offers a platform to publish application-oriented and theoretical work in the field of industrial engineering in a citable manner.

The discontinuously appearing publications deal with MTM in the field of "Industrial Engineering" in a narrow and broader sense. They address new and continuous developments, practical applications in known and new fields as well as theoretical findings and aspects for the foundation and dissemination of MTM.

In this publication, the focus of our considerations and explanations is the importance of the method level (or process type) for the future application of MTM process building block systems in the context of changing work systems. We also explain the importance of MTM-HWD in virtual planning and "Approved by MTM" and the concept of "Simulation Analysis" – as a new category of MTM analysis – for the use of digital motion data.

Peter Kuhlang, August 2020

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Preamble

In this preamble we address, right at the beginning, a fundamental consideration in the application of MTM in changing work systems, which, however, often receives insufficient attention in practice. It is also the guiding principle of this publication:

> **The selection of the right MTM process module system suitable for the operational application as well as of operational, company-specific systems (structure levels, standard procedures) must always be made depending on the prevailing process type.**

1 Motivation and initial situation: The change of method level of work systems

During the last 20 years (especially in the automotive industry and its suppliers) the design of work systems and work organization has changed continuously, especially the cycle times of the lines have decreased. In the vocabular of MTM this means that the method level resp. the process type has developed; for example from process type 2 to process type 1. Human work in the modern context (of the automotive industry) is in many areas characterized by cyclically recurring activities. (In automotive engineering, cycle times are mainly around 60 seconds). It must also be taken into consideration that the influence of ergonomic evaluation and the increasing digitalization of planning human work lead to a constant refinement and specification of planning and evaluation methods. Consistently, from an MTM point of view and the application of MTM process building block systems, this means a trend and an orientation towards "more precise" MTM process building block systems such as MTM-1 and MTM-HWD[1].

> **MTM-1 defines the MTM standard performance and thus is the basis for all higher aggregated MTM process building block systems.**

Systems such as MTM-UAS, Daimler C-Values or the Standard Data of BMW Group (BMW SD) are very widespread today (in the automotive industry). However, due to the development background of MTM-UAS in the 1970s, it is (only) up to a limited extent suitable to adequately reflect the demands and challenges of the modern working world. The new process building block system MTM-HWD was developed specifically on the basis of MTM-1 in order to describe working methods of today's working world in the best possible way. In concrete terms, this means an application in areas or work systems with an expected high method level (high degree of routine) in the cycle time range of 30 to 120 seconds. MTM-HWD has been developed in such a neutral way that it can be coupled with any ergonomics evaluation method[2]. With MTM-HWD it is also principally possible to map working methods to a lower method level (e.g. MTM-UAS method level). For this purpose, however, it is necessary to consider the variance of working methods resulting from the lower routine level.

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1 Basically, it should be pointed out at this point that MTM-1 - as a basic system - can always be applied in all areas (process types). However, it must be checked for each individual case whether this procedure is reasonable or economical.

2 cf. Kuhlang, 2018; Brandl et al., 2019; Benter, Kuhlang, 2019

2 Introduction and objectives

This publication expresses the views and explanations of MTM ASSOCIATION e. V. (MTMA) **on the future use** - more specifically on the further development of the use and application - of the **MTM process building block systems** in the context of changing work systems in industrial companies. It also highlights the importance of **MTM-HWD as a core element of digitization and virtualization**, of "**Approved by MTM**" and of MTM simulation analysis for processing digitally generated motion data.

This position paper describes the current view of the MTMA regarding the development of the future application of the MTM process building block systems (Chapter 4) as well as the significance of MTM-HWD in virtual planning (Chapter 5), in order to serve (member companies) as argumentation support. It explains methodical backgrounds, expresses the position of the MTMA and shows developments. Thus, it serves as a basis for a uniform, coordinated approach in the MTM community. It offers answers to application questions about the MTM process building block systems that have been brought to the MTMA in the recent past.

3 Basics

3.1 Method level or process type

The terms "method level" and "process type" are used synonymously and are of fundamental importance for applying MTM. The method level has to be determined for an (existing or planned) work system in order to be able to select and apply the suitable or the "right" MTM process building block system in order to describe and evaluate work processes. The method level or process type is a measure of how high the chance to establish (form) routine in a work system can be and how high the variance of work methods (Variation of individual operators methods) is. The method level or process type is used to classify the different MTM process building block systems according to criteria and characteristics (see table 1) [3].

Method level		**high**	**medium**	**low**
Process type		1 Mass production	2 Serial production	3 Single/Job shop production
Chance to establish routine		high	middle	low
Variation of individual operators methods		low	middle	high
Example		Automotive assembly	Aircraft assembly	Car repair shop
Attribute	**Cycles**	Continuously short-cycled repetitions	Temporarely longer-cyclic repetitions	No cyclic repetitions
	Details about work process	Motions (basic motions)	Partial part of process (Operations; general conditions)	Overall process (Operations; general conditions)
	Work system	Defined product variants	For defined product variety	For any processes and product variety
	Supply principle of work system	Delivery	Pick-up with supply	Pick-up

Table 1 Overview about method level

[3] cf. Kuhlang, 2019, p. 6

The (exemplary) expressions of the criteria and characteristics of the method level or process type support the applicator in distinguishing the process types and help in the assessment or determination of the actually existing method level.

The degree of resolution or abstraction of an MTM process building block systems is explained in the following as an example using the "flight altitude during a flight".

The higher an aircraft flies - for example, at cruising altitude for a city or intercontinental flight - the fewer details on the ground can be seen or perceived exactly and thus cannot be assessed or evaluated. The analogy to high flight altitude is the low method level. The building blocks of the corresponding process building block systems are "constructed" in such a way that they deliberately do not "perceive" details (of the movements or some work contents); these details were already "immanently" taken into account during the development of the process building block system by means of corresponding data construction principles. The workflow/work content or the movements are thus consciously described in a "less precise" way.

However, if the flight takes place at a lower altitude, for example during a helicopter flight or during the landing approach, the details on the ground can be recognized and perceived more accurately. The analogy to low altitude is the high method level. The building blocks of the corresponding process building block system are "constructed" in such a way that they consciously "perceive" details (of movements or some work contents); these details were considered as separate building blocks in the development of the process building block system. The work process or the movements are thus consciously described in a more "precise" way.

3.2 Process type and MTM process building block systems

The overall structure of the application-neutral MTM process building block systems provides an overview of the relationship between the MTM process building block systems and the process type, which is visualized below (Figure 1 and Figure 2).

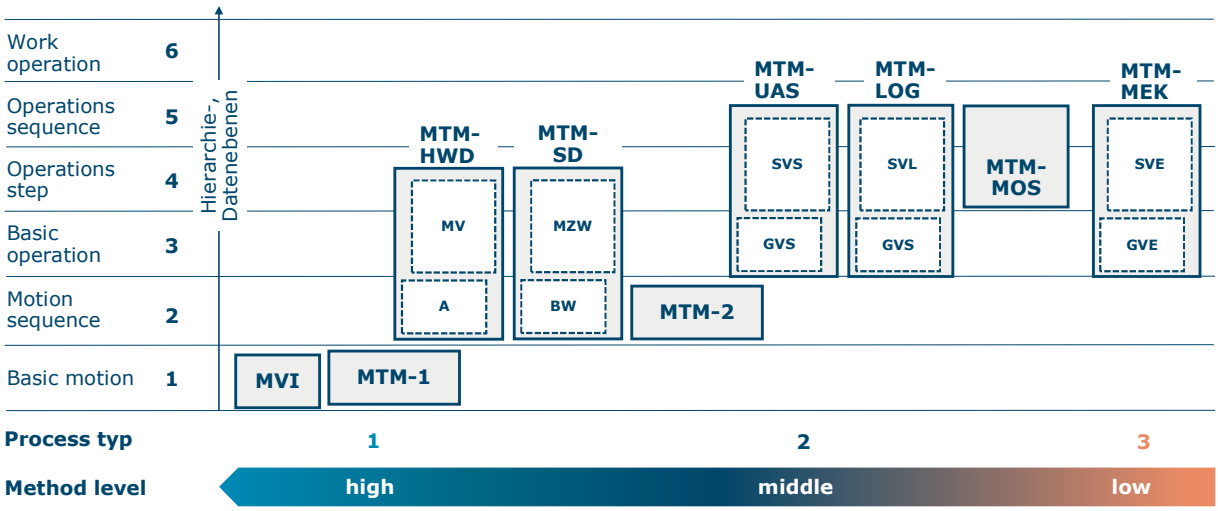

Figure 1 Structure of the application-neutral MTM process building block systems[4]

MTM process building bloc systems			
MVI	MTM-Sichtprüfen / MTM Visual Inspection		
MTM-1	MTM-1 (basic system)		
MTM-HWD	Human Work Design (HWD)	A	HWD-Aktionen (HWD Actions)
		MV	HWD-Modellierungsvorlagen (HWD Modelling Templates)
MTM-SD	Standard-Data (SD)	BW	SD-Basiswerte (SD Basic Values)
		MZW	SD-Mehrzweckwerte (SD Multi Purpose Values)
MTM-2	MTM-2		
MTM-UAS	Universal Analysiersystem (UAS) Universal Anlayzing System (UAS)	GVS	UAS-Grundvorgänge Serie (UAS Basic Operations Series)
		SVS	UAS-Standardvorgänge Serie (UAS Standard Operations Series)
MTM-LOG	MTM-Logistik / MTM Logistics	SVL	Standardvorgänge Logistik (Standard Operations Logistics)
MTM-MOS	MTM-Office-System		
MTM-MEK	MTM in der Einzel- und Kleinserienfertigung (MEK) MTM for Single and Job Shop Production (MEK)	GVE	MEK-Grundvorgänge Einzelfertigung/Kleinserie (MEK Basic Operations Single)
		SVE	MEK-Standardvorgänge Einzelfertigung/Kleinserie (MEK Standard Operations Single)

Figure 2: Legend for the Structure of the application-neutral MTM process building block systems

The selection and application of MTM process building block systems as well as of company-specific systems (standard operations) must always be carried out depending on the process type prevailing at the users field of application. The following overview arranges the MTM process building block systems according to "their" method level and can be used as selection support (see figure 3).

4 cf. Kuhlang, 2018, p. 13

Attribute to characterize different **types of process**	**Process type 1** Mass production	**Process type 2** Serial production	**Process type 3** Single/job shop production
Cycles	Continuously short-cycled repetitions	Temporarely longer-cyclic repetitions	No cyclic repetitions
Details about work process	Motions (basic motions)	Partial part of process (Operations; general conditions)	Overall process (Operations; general conditions)
Work system	Defined product variants	For defined product variety	For any processes and product variety
Supply principle of work system	Deliverly	Pick-up with supply	Pick-up
Variation of indvidual operators methods	low	middle	high

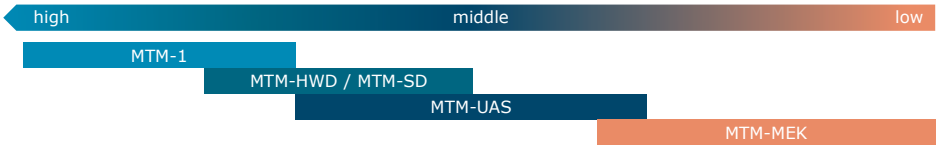

Figure 3 Process type and MTM process building block systems at a glance

In summary, this means: The MTM process building block system must match the existing method level (this must be determined in the concrete application case). If another MTM process building block system is used, a systematic application error occurs. This leads to unreliable results with the consequence that the reported MTM times will be too high or too low.

4 MTMA positions for the use of MTM process building block systems

1. Depending on the method level of the MTM process building block system or of a company-specific system, or depending on the required degree of abstraction level of the description and evaluation of a work content, the "person responsible" in the company must determine whether the system used is the correct one or whether a change or a introduction of a new MTM process building block system is or will be necessary. MTMA recommends the early involvement of the employee representatives.
2. Especially for the MTM process building block systems (MTM-1, MTM-2, MTM-SD, MTM-UAS, MTM-MEK), MTMA will not supplement or modify application-neutral blocks and rules in order to not change the field of application of a system.
3. The MTM standard performance is a neutral and worldwide accepted reference, which serves as a basis for a company-specific reference performance. When introducing or adapting company-specific performance expectation factors, which have been agreed upon between management and employee representatives and are to be changed or adapted, the selection and correct application of MTM process building block systems is of decisive importance.
4. The influences on the MTM process building block systems from the ergonomics assessment and through the increasing digitalization of the planning of human work lead to a constant refinement and specification of the planning and evaluation methods. For MTM, this means that there is a tendency in the industry to use MTM process building block systems with higher resolution such as MTM-1 and MTM-HWD.
5. With MTM-HWD, MTMA offers an MTM process building block system which opens a door for the industry to a more efficient and holistic design of human work as well as to the use of future digital technologies in process design.
6. With MTM-HWD, MTMA has succeeded in taking the fundamental methodological step to (partially) automatically generate MTM analyses from digital motion data, which can achieve the quality criterion or seal of approval "Approved by MTM" and uses the MTM standard performance as a neutral, recognized reference basis.
7. Especially due to its high level of methodology and the chronological description of movement and work processes, MTM-HWD offers a valid basis for the description and evaluation of human work in the processing of digital movement data.

If necessary, MTMA is available to provide advice and expertise for the selection or replacement of an MTM process module system.

5 Meaning of MTM-HWD in virtual planning

5.1 Outlook

A productive and ergonomic design of human work plays a central role in maintaining the competitiveness of industrial companies. In order to master this task successfully, different methods are used to evaluate and design work processes. The most common methods (MTM, REFA, EAWS, RULA, NIOSH, LMM) examine either productive or ergonomic aspects. In addition, the analysis of work processes requires a high manual data collection and analysis effort by the method user. These factors lead to the fact that not all industrial workplaces are designed to be both productive and ergonomic.

With MTM-HWD, a method was developed, which allows an integrated analysis of the productive and ergonomic aspects. Although both aspects are analyzed in one step, the application of this method still requires a certain amount of effort.

One way to reduce this effort is the automatic acquisition and analysis of digitized human motion data. These data describe human movements and include, for example, distances travelled, joint positions or object interactions. The technologies human simulation, motion capture and virtual reality (VR) are particularly suitable for capturing or generating this motion data. Due to the progress of these technologies in recent years, their use at a large number of workplaces is conceivable[5].

5.2 MTM-HWD as core element of digitization and virtualization

Core of MTM-HWD is the integrated temporal and ergonomic evaluation of manual work processes. It is therefore more than just a new MTM system for productivity evaluation. It supports a holistic design of work processes. In order to achieve this goal, the HWD user records the executed actions in a manual work process and their temporal and ergonomic influencing variables. For simplification and systematization of the analysis, the influencing variables are based on the human body parts and are also visualized as easily interpretable pictograms[6].

Thus MTM-HWD not only enables a comprehensive manual evaluation and design of manual work processes. Through the objective description of human movements it also forms the basis for the digitalization of work planning and design.

The Industrial Engineer of the future will therefore be able to use digital tools to plan work processes in detail with MTM-HWD. Especially technologies that process motion data have a high application relevance. These include, for example, human simulation,

5 cf. Benter, Kuhlang, 2019; Benter, et al. 2019
6 cf. Finsterbusch, Kuhlang, 2015

motion capture and VR. The connection between the digital world and real human work is created by translating the digitally available information into suitable methods such as MTM-HWD.

> **Deriving correct MTM-HWD analyses from automatically obtained motion data is thus a key to the industrial engineer's reliable use of digital planning tools.**

For the creation of a MTM-HWD analysis a lot of information is necessary, which describes the human work in detail. The successful derivation of this information from digital planning tools is therefore the basis for the generation of so-called simulation analyses (see Figure 4).

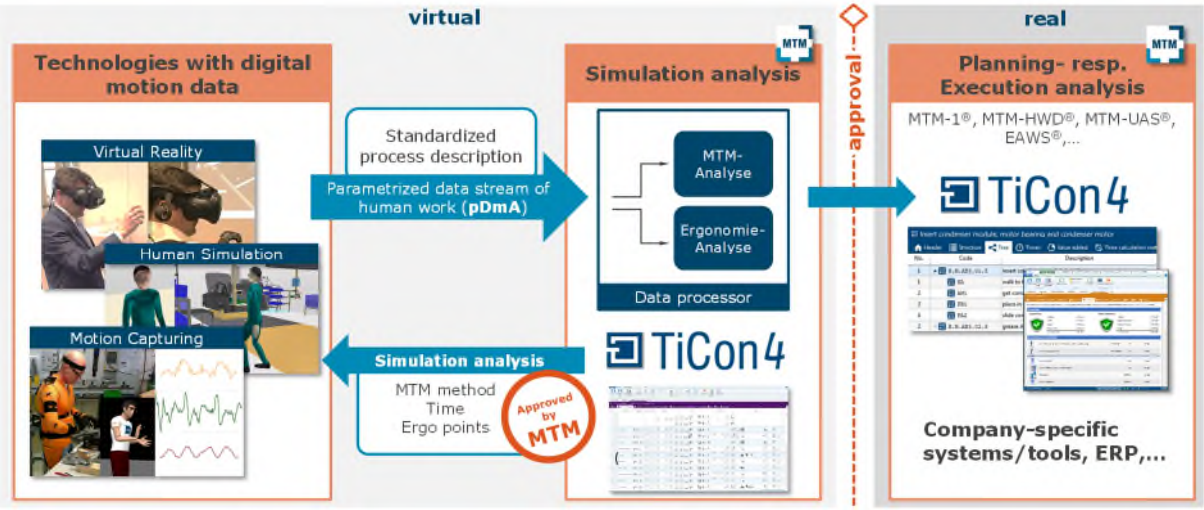

Figure 4 Transfer of digital motion data in MTM analysis: Simulation analysis[7]

Simulation analyses describe and evaluate the digitally described motion sequence (the working method). In other words: "What you see (simulate, capture) is what you get (describe)! A simulation analysis thus also describes processes that do not take place in reality or in the later work process, if the digital tools capture the processes in this way[8].

By using the MTM standard performance, MTM-HWD allows assigning humanly feasible planned times to the digitally depicted work processes. The integrated ergonomic evaluation ensures that the digital processes are humane. Thus, the simulation analyses can be labelled with the quality seal "Approved by MTM". Despite the extensive possibilities of the digital planning tools, it will still be necessary to have the simulation analyses approved by an MTM or IE expert. Only then will they be transferred to planning or execution analyses. In this way, the digitally depicted work process is deliberately transformed into a fixed working method (see Figure 4).

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7 cf. Kuhlang, 2019
8 cf. Kuhlang, 2019

It has been shown that digital planning tools are able to (partially) automatically derive HWD analyses from digital human motion data. This is of great importance for a productive and ergonomic design of human work in the increasingly digitalized production. The process building block system MTM-HWD thus has the potential to enable the industrial engineer of the future to design human work targeted and humane based on motion data.

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