A Study on Defining Standard Movement Sets in Sewing Using the MTM Method

Esra Dirgar, **Okşan Oral***
Ege University, Emel Akın Vocational Training School, İzmir, Turkey
*Corresponding author: oksan.kansoy@ege.edu.tr
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Professional paper

There are different techniques to determine the timing of operations. Among these techniques, the Methods Time Measurement (MTM) method is used as a clear, accurate and improvable technique that increases efficiency. In standard time determination using the MTM method, all of the employee's movements are analyzed sequentially from start to finish. This makes it possible to identify unnecessary additional movements during work that slow down the work. For this reason, the MTM method is not only a method for calculating standard time, but also a great help in developing and improving methods. The aim of this study is to carry out work measurement using the MTM method and to highlight its importance for production planning. With this approach, considering the production scheme for skirts, sample studies were conducted on the application of the MTM method in lockstitch, overlock, buttonhole, button and ironing processes.

Keywords: *Work method; MTM System; Skirt sewing operation; Time study; Method study*

Stručni rad

Definiranje standardnih pokreta u šivanju pomoću MTM metode

Postoje različite tehnike za određivanje vremena operacija. Među tim tehnikama koristi se metoda mjerenja vremena (MTM) kao jasna, točna i poboljšana tehnika koja povećava učinkovitost. U standardnom određivanju vremena korištenjem MTM metode, svi pokreti zaposlenika analiziraju se sekvencijalno od početka do kraja. To omogućuje prepoznavanje nepotrebnih dodatnih pokreta tijekom rada koji usporavaju rad. Iz tog razloga, MTM metoda nije samo metoda za izračunavanje standardnog vremena, već i velika pomoć u razvoju i poboljšanju metoda. Cilj ovog rada je provesti mjerenje rada MTM metodom i ukazati na njen značaj za planiranje proizvodnje. Ovim pristupom, s obzirom na proizvodnu shemu za suknje, provedena su ogledna istraživanja primjene MTM metode u procesima šivanja, overlocka, rupica za gumbe, gumba i glačanja.

Ključne riječi: *metoda rada; MTM sustav; operacija šivanja suknje; određivanje vremenskih normi*

1. Introduction

Efficiency, time and costs in clothing production are very important for process management and competitiveness. To be successful in the processes and in competition, the company must ensure optimization of all its elements [1]. For this reason, companies should proceed in a planned manner and keep all processes under control. One of the methods that help companies succeed in this regard is the Predetermined Time Standard technique, which is an important measurement method for companies. The most commonly used time standard system is the MTM (Methods Time Measurement) method.

The MTM method is based entirely on the measurement of order time [2]. Eliminating unnecessary process steps in the manufacture of garments and standardizing the procedures used not only makes the manufacturer's work easier, but also reduces the possibility of making mistakes [3]. When determining standard times using the MTM method, all of the employee's movements are analyzed individually from start to finish. This also makes it possible to recognize additional movements that are made unnecessarily during the work and slow down the work. With this approach, the MTM method is not only a method for calculating standard time, but also a great help for developing the method [4].

The objectives of the MTM method are to standardize production using suitable methods and tools, to achieve the highest possible efficiency throughout the process and to avoid losses. With the MTM method, movements are analyzed and non-value-adding movements are identified. By eliminating them, time is shortened and efficiency is increased. This can also be used to describe the working method and in vocational training. From this point of view, the Kaizen philosophy, which aims for continuous improvement, is achieved.

The MTM system can be used for the creation of working methods, the definition of time norms and the design of workplaces already in the phase of the design of production processes of work systems and workplaces as well as for the redesign of the existing workplace. When creating work methods, the technological operation is broken down into sub-operations and basic movements. On the basis of an analysis, the most favourable working method is determined and worked out over time for the execution of technological activity [5].

Studies of the work process using the MTM system make it possible to find, develop and prepare optimal working methods before the start of garment production, design garment technology production systems, choose the optimal arrangement of equipment and machines, train workers according to the established optimal working method, determine the degree of utilization of production capacities and monitor the execution of production plans, rationalize existing procedures and working methods, and determine the actual and real norms regarding the composition of personnel and installed equipment [6,7].

The aim of this study is to carry out work measurement using the MTM method and to highlight its importance for production planning. With this approach, considering the production scheme for skirts, sample studies were conducted on the application of the MTM method in lockstitch, overlock, buttonhole, button and ironing processes.

2. General Information

2.1 MTM Movement

In the MTM method, there are 5 basic movements, 3 basic movements with the hands, 2 visual functions, foot-leg movements and body functions such as changing the direction of the body.

The MTM methodology is based on five basic movements: to reach, to grasp, to move, to position and to release (Fig.1 and Tab.1).

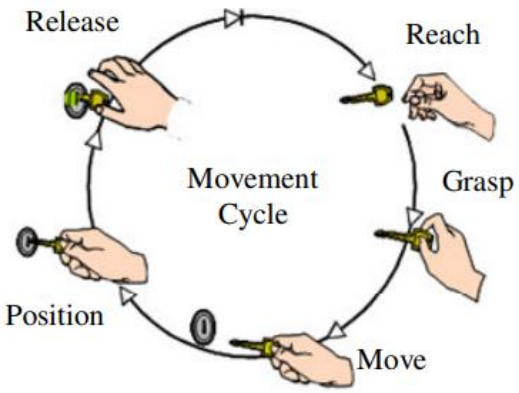

Fig. 1 The five basic movements in MTM [8].

Kirin and Sajatovic [5], using MTM method, gave an overview of possible individual suboperations contained in the technological sewing operation and perform of the technological suboperation of sewing. Within the technological suboperation of sewing the methods of guiding the work piece in the sewing process, various methods of seam bar tacking, use of auxiliary devices, suboperations during sewing breaks, various methods of cutting of the thread regarding the technical equipment of the sewing machines, seam properties, and level of worker training were developed.

Tab. 1 MTM movement chart

MTM MOVEMENT CHART	
Basic Movement by Hand	Reach - R
	Move - M
	Position - P
	Crank - C
	Release - RL
	Grasp - G
	Apply Presure - APA
	Disengage - D
	Turn - T
Body, Leg and Foot Motions	Hinged an ankle - FM
	Hinged an knee or hip in any direction - LM
	Side Step -SS
	Turn Body - TB
	Bend / Arise from Bend - B/AB
	Stoop - S
	Kneel on one knee - KOK
	Kneel on both knees - KBK
	Sit / Stand - SIT /STD
	Walk - W
Eye Action and Eye Focus	Eye Travel - ET
	Eye Focus - EF

Almeida and Ferreira [8] gave details with regard to the methods and results obtained through the application of MTM in two companies of the automotive sector, and a company that manufactures household appliances. It is concluded that the MTM methodology is a useful tool for the planning and organization of operators´ working processes, and that combined with other applied methods it can generate a significant increase in productivity.

Kirin and Sajatovic [9] presents the process of determining the working method and normal times for the technological operation of runstitching women's blouse collars, which includes the design of an ergonomically designed workplace, the selection and technical equipment of the universal sewing machine and the determination of the optimal work method and normal times using the Methods-Time Measurement (MTM) system. The research results obtained indicate that the technical equipment of a universal sewing machine has a significant impact on the structure of the technological sewing operation and the working method, i.e. the number of auxiliary manual technological suboperations.

3. Material and Methods

Predetermined time systems are advanced techniques and are used to determine the time required to perform various operations by using predetermined time standards for different movements without relying on direct observations and measurements. These systems have had a very limited application for many years since they first appeared. However, as their numbers have increased over time and users have better understood the benefits and limitations of these systems, their areas of application have expanded [10].

Predetermined time systems are based on the determination of the normal duration of the process on the basis of standard time specifications for basic movements. What is important in this system is not the determination of the duration, but the determination of the movements of the process. When movements are determined, the relevant time is determined by reading the table value for the movement. For this reason, the detection of process movements is carried out by trained work researchers [10]. When an appropriate analytical technique is applied to the subject, this method is superior to other methods that design and evaluate human labor by a logical arrangement of the necessary movement elements. The logical consequence of such an analytical evaluation is the collection of time values, which are readily available in the form of given time values. This is how basic time is spontaneously created [11].

The material for this study is the classic skirt model. The method used was the MTM method.

First, the production flow diagram of the classic skirt was created. Considering the operations in the production scheme, 1 sample of each machine and sewing group was selected and the unit times of the operations were calculated by applying the rules of the MTM method.

3.1. MTM Core Time Values and Skirt Operation Names

In the MTM method, the time unit is expressed as a TMU (Time Measurement Unit). The MTM time conversion values are given in Tab.2.

Tab. 2 MTM time conversion values

MTM TIME CONVERSION VALUES			
TMU	Second	Minute	Hour
1	0,036	0,0006	0,00001
27,8	1	-	-
1666,7	-	1	-
100 000	-	-	1

Table 3 shows the numbers and names of the rock operations.

The classic skirt consists of one part on the front and 2 parts on the back. There are 2 darts on the front and back as well as a zipper and a slit in the middle of the back. The belt at the waist is connected with 1 buttonhole and a button (Fig.2).

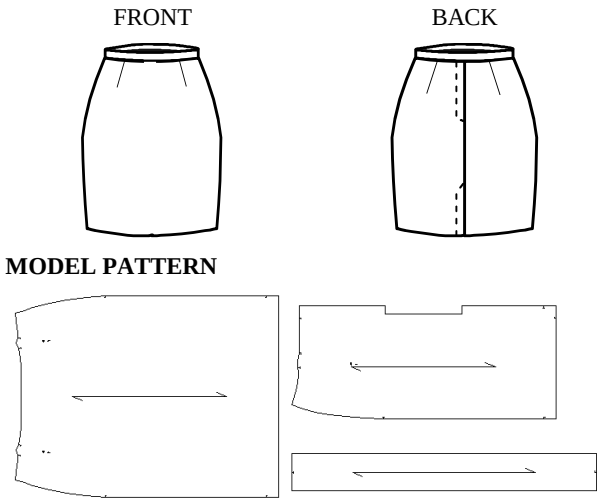

Fig.2 Classic skirt model

Tab.3 Skirt operation numbers and names

SKIRT OPERATIONS	
No	**Operation name**
1	Sewing the front darts
2	Front 3 side overlock
3	Sewing the left back darts
4	Left back 3 side overlock
5	Sewing the right back darts
6	Right back 3 side overlock
7	Back seam
8	Back ironing
9	Attaching zipper
10	Sewing slit
11	Side seams
12	Adhesiving interlining to the belt
13	Belt end sewing
14	Sewing belt on skirt
15	Edge stitching on belt
16	Hem stitching
17	Buttonhole
18	Attaching button
19	Final trimming

After determining the operations in the production of the skirt, the operations "Sewing the front darts" of the lockstitch method and machine, "Front 3-sided overlock" of the overlock method and machine, "Back ironing" of the ironing method and machine", "Buttonhole" for the buttonhole method and machine and "Sewing on buttons" for the button method and machine were selected as examples for the study (among 19 operations). The selected processes were recorded on video, observed and MTM analyzes of the processes were carried out.

3.2. Machine Features Used in Sewing Time Calculation and Process Time

Stitch density, sewing speed and stitch length (Eq.1) are required to determine the process times for sewing operations. The machine characteristics most commonly used in the production phase to perform these calculations are listed below.

The lockstitch machine used in the study is computerized (automatic presser foot lift and automatic thread trimming). The overlock machine - 3 thread is a mechanical machine with thread trimming device.

Lockstitch Machine:

Sewing speed: 5000 sti/min, Stitch density: 5

Overlock Machine - 3 Thread:

Sewing speed: 7000 sti/min, Stitch density: 3

Buttonhole Machine:

Sewing speed: 4000 sti/min, No. of stitches: 20

Button Sewing Machine:

Sewing speed: 3000 sti/min, No. of stitches: 16

Equation 1 gives the process time (p.t) formula

$$p.t\ (Time - TMU) = \frac{\frac{Stitch\ density\ (Number\ of\ stitches)}{Sewing\ speed\ x\ Stitch\ lenght\ process}}{0{,}0006} \quad (1)$$

Time norms of different stitches (lockstitch, overlock, ironing, buttonhole and button operations) were analyzed on the classic skirt, whose sewing workflow was given using the MTM System.

4. Results and Discussion

4.1. Sewing the front darts

Reach the front piece with the left hand from a distance of 50 cm, move it to a distance of 40 cm, position it on notches with both hands and position it under the needle, sew 7 cm, tack, cut the thread automatically and release it with the right hand to a distance of 50 cm. Figure 3 shows workplace design for the technological operation of sewing the front darts.

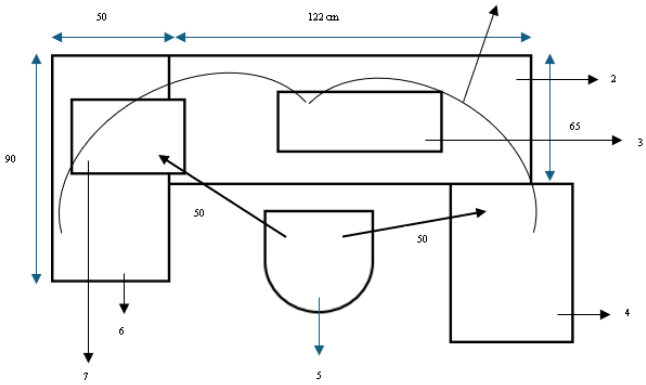

Fig.3 Workplace design for the technological operation of sewing the front darts: 1-maximum reach zone; 2-sewing machine table; 3-head of the sewing machine; 4-table for putting down the pieces; 5-chair; 6-table on which bundles are placed; 7-front piece

Tab.4 Sewing the front darts

SEWING THE FRONT DARTS				
Left Hand Movement	**Symbol**	**TMU**	**Symbol**	**Right Hand Movement**
Reach on front body	R50B	18.4		
Grasp	G1A	2		
Move	M40C	18.5		
Position on notches	P2SSD	25.3	P2SSD	Position on notches
Position under the needle	P2SSD	25.3	P2SSD	Position under the needle
Release	RL1	2	RL1	Release
Start to machine	FM	8.5		
Sewing 7cm	p.t	11.7	R30A G5	Reach on the back stitching button Grasp the lever
Back stitch sewing 1cm		10.6	APA	Apply force
		0	RL2	Release the back stitching button
		12.8	R30B	Return the hand to the workpiece
Foot motion	FM	8.5		
Response time for the thread trimming mechanism	t	4		
Foot motion	FM/2	4.3		
		18 2	M50B RL1	Move Release
TOTAL		171.9		

Tab.4 shows the movement flows and times sewing the front darts created using the MTM method.

4.2. Front 3 Side Overlock

Reaching the front from a distance of 50 cm with the left hand, moving to a distance of 40 cm, positioning under the needle with both hands, performing the three-sided overlock with the help of two hands, thread trimming with a trimming device and releasing to a distance of 50 cm with the right hand. Fig.4 shows the workplace layout for the technological operation of the front 3-sided overlock. Fig.4 shows workplace design for the technological operation of front 3 side overlock.

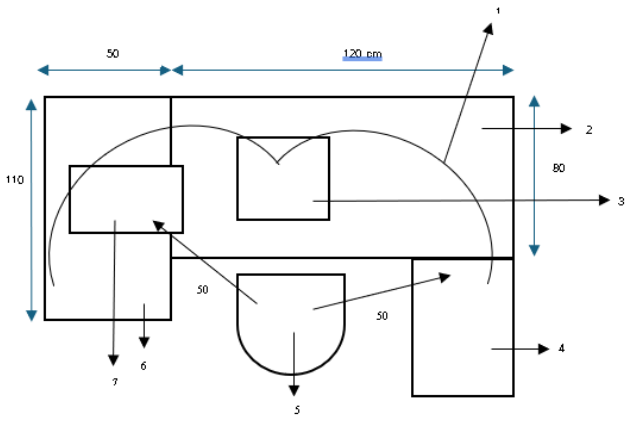

Fig.4 Workplace design for the technological operation of front 3 side overlock: 1-maximum reach zone; 2-sewing machine table; 3-head of the overlock machine; 4-table for putting down the pieces; 5-chair; 6-table on which bundles are placed; 7-front piece

Tab.5 shows the movement flows and times front 3 side overlock created using the MTM method.

4.3. Back Ironing

Reach the front part from a distance of 50 cm with the left and right hand, move it to a distance of 40 cm, position it under the needle with both hands, reach the iron at a distance of 60 cm with the right hand, move the 2 kg iron by 60 cm, perform the ironing process 4 times, move it to its place at a distance of 60 cm with the right hand, release the iron, release the ironed product at a distance of 50 cm with the right hand.. Fig.5 shows workplace design for the technological operation of back ironing.

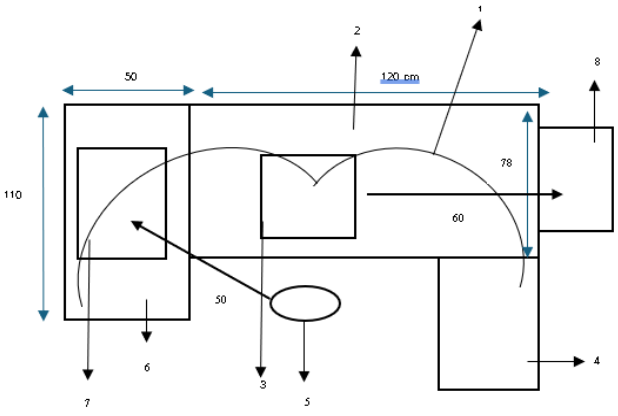

Fig.5 Workplace design for the technological operation of back ironing: 1-maximum reach zone; 2-sewing machine table; 3-head of the button/buttonhole machine; 4-table for putting down the pieces; 5-man wiht stand; 6-table on which bundles are placed; 7-front piece; 8- iron

Tab. 5 Front size 3 side overlock

FRONT SIZE 3 EDGE OVERLOCK				
Left Hand Movement	**Symbol**	**TMU**	**Symbol**	**Right Hand Movement**
Reach on front body	R50B	18.4		
Grasp	G1A	2		
Move	M40C	18.5		
Position under the needle	P2SSD	25.3	P2SSD	Position under the needle
Release	RL1	2	RL1	Release
Start to machine	FM x 3	25.5		
Sewing 64,5cm	p.t	45.8	p.t	Sewing 64,5cm
Sewing 49cm	p.t	34.8	p.t	Sewing 49cm
Sewing 64,5cm	p.t	45.8	p.t	Sewing 64,5cm
Lift the presser foot	FM x 2	17		
Rotate the work piece	M30C x 2	30.2	R30E x 2	Return the hand to the workpiece
Kinematic reaction[5]	t x 2	8		
Lower the presser foot	FM x 2	17		
Move to the trimming device	M10C	7.9		
Cut off	AF	3.4		
		18 2	M50B RL1	Move Release
TOTAL		321.6		

Tab. 6 Back ironing

Back Ironing				
Left Hand Movement	**Symbol**	**TMU**	**Symbol**	**Right Hand Movement**
Reach on back body	R50B	18.4	R50B	Reach on back body
Grasp	G1A	2	G1A	Grasp
Move	M40C	18.5	M40C	Move
Position on the machine	P2SSD	25.3	P2SSD	Position on the machine
Release	RL1	2	RL1	Release
		21.2	R60B	Reach on iron
		2	G1A	Grasp
		1.6	SC2	Iron weighing 2 kg
		26.2	M60C x W (for 2 kg)	Move
		10.6	APA	Apply force
		42	M20B x 4	4 times ironing motion
		1.6	SC2	Iron weighing 2 kg
		21.22	M60B x W (for 2 kg)	Move
		2	RL1	Release
		21.2	R60B	Reach for the ironed item
		2	G1A	Grasp
		18 2	M50B RL1	Move Release for the ironed item
TOTAL		237.82		

Tab.6 shows the movement flows and times back ironing created using the MTM method.

4.4. Buttonhole Making

You reach the front piece from a distance of 50 cm with your left hand, move it to a distance of 40 cm, position it under the needle with both hands, start the machine, reach the piece with your right hand from a distance of 10 cm and release it at a distance of 50 cm. Fig.6 shows workplace design for the technological operation of buttonhole and attaching button.
Tab.7 shows the movement flows and times buttonhole created using the MTM method.

Tab.7 Buttonhole

Buttonhole				
Left Hand Movement	**Symbol**	**TMU**	**Symbol**	**Right Hand Movement**
Reach for the skirt	R50B	18.4		
Grasp	G1A	2		
Move	M40C	18.5		
Lift the presser foot	FM	8.5		
Move	M20C	11.7	M20C	Move
Position under the needle	P2SSD	25.3	P2SSD	Position under the needle
Release	RL1	2	RL1	Release
Start to machine	FM	8.5		
Buttonhole operation - 1,5 cm	p.t.	12.5		
		6.3	R10B	Reach the workpiece
		2	G1A	Grasp
		18 2	M50 RL1	Move Release
TOTAL		135.7		

Tab.8 Attaching button

ATTACHING BUTTON				
Left Hand Movement	**Symbol**	**TMU**	**Symbol**	**Right Hand Movement**
Reach for the skirt	R50B	18.4	R50B	Reach for the skirt
Grasp	G1A	2	G1A	Grasp
Move	M40C	18.5	M40C	Move
Lift the presser foot	FM	8.5		
Move	M20C	11.7	M20C	Move
Position under the needle	P2SSD	25.3	P2SSD	Position under the needle
Release	RL1	2	RL1	Release
		18.4	R50B	Reach the button
		8.7	G1C2	Grasp
		18.5	M40C	Move
		52.1	P3SSD	Position
		2	RL1	Release
		4.5	R5B	Reach the workpiece
		2	G1A	Grasp
Start to machine	FM	8.5		
Sewing button	p.t	28.4		
Reach the workpiece	R20B	10	R20B	Reach the workpiece
Grasp	G1A	2	G1A	Grasp
Release the workpiece	M50B RL1	18 2	M50B RL1	Move Release the workpiece
TOTAL		261.5		

4.5. Attaching Button

Reach the front piece from a distance of 50 cm with the left and right hand, move it to a distance of 40 cm, position it under the needle, reach the button from a distance of 50 cm with the right hand, move it 40 cm away, position it and release it, press the pedal, sew on the button, reach it from a distance of 20 cm with the right and left hand and release the piece from a distance of 50 cm

Tab.8 shows the movement flows and times attaching button created using the MTM method.

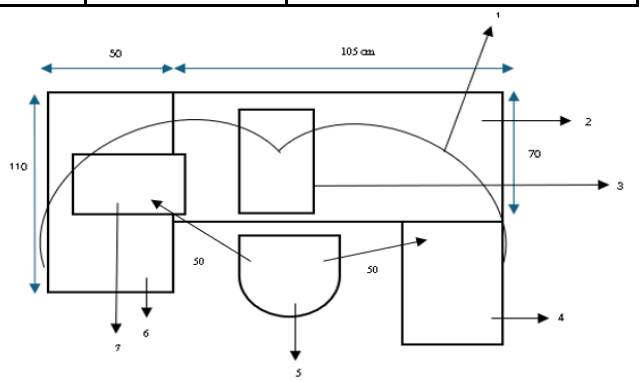

Fig.6 Workplace design for the technological operation of buttonhole and attaching button: 1-maximum reach zone, 2-sewing machine table, 3-head of the button/buttonhole machine; 4-table for putting down the pieces; 5-chair; 6-table on which bundles are placed; 7-front piece

Skirt unit time can be calculated by using the MTM method for the skirt, taking into account the rules in movement applications in the given sample movement sets.

5. Conclusions

The MTM method is a dynamic method that enables a step-by-step analysis of the way you work and delivers precise and perfect results. All body movements are precisely defined in advance and prepared in the form of schedules. Therefore, during the operation, it is not necessary to measure the time, estimate the power, make the appropriate arrangement and perform all the operations required to perform the study with a stopwatch. It makes it possible to calculate the unit time of the operation without these operations. It also makes it possible to estimate production costs before starting production. The only requirement is that you know the functions and details of this method well.

In addition to determining unit times using the MTM method, it is a very important factor to ensure that the employee performs the correct movements and improves the process. This is because when a work process is analyzed using the MTM method, the hand, eye, head and foot movements are determined in detail and it is ensured that the employee performs these movements correctly. The Kaizen philosophy is therefore achieved by improving work processes, which is one of its most important goals.

With the MTM method:

- Time study and method study function as a whole. In this way, the separation between the time of the operation and the method of working is eliminated and both self-control and continuous improvement in production are achieved.
- In the MTM method, there is no performance assessment, which is the biggest challenge for the researcher and is left to the researcher's initiative.
- With this method, it is sufficient to define the operations on the basis of movements.
- By defining operations based on movements, additional movements of the employee are eliminated and the best working method is achieved.
- MTM ensures the application of ergonomic principles in the design of working methods and workstations, thereby reducing workload and performance time and increasing efficiency.
- It is used in employee training.

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