Peter Almström
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Predetermined Time Systems and SAM

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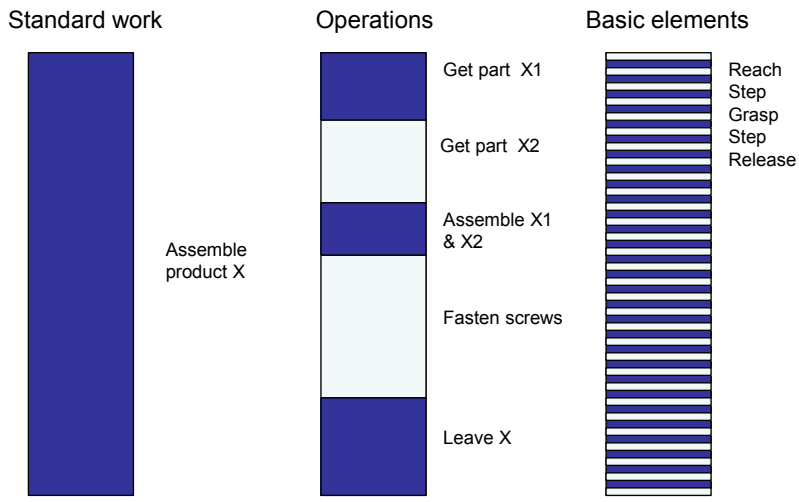
Learning objectives

- After this lecture the students will be able to…
  - Explain the historical development of PTS
  - Motivate the use of PTS
  - Select appropriate PTS for the task depending on length of work cycle and type of work
  - Use the SAM method



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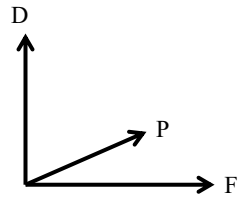
Predetermined time systems

- Other names:
  - Basic motion times
  - Synthetic times
  - Elementary times
  - Predetermined motion time system
  - Swedish: *Elementartidssystem*

Time for an element

- The time for an element depends on:
  - Distance of movement
  - Force (weight, resistance)
  - Precision



Predetermined time application

1. Standard data development
   - Efficient development of standard times
   - Sort of simulation, use in early phases
2. Judgement of ”a fair day’s work”
3. Methods analysis

MTM – worker acceptance

- Doing a fair day's work. Fairness vs. co-workers, fairness vs. employer.
- Performing a task according to optimized work methods in an optimized work environment.
  - Fatigue-free work
  - Avoiding monotonous strain and overburdening,
  - Work station adapted to the physical requirements of the employees

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History of work studies

Frederick Winslow Taylor

(1856-1915)

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Waste

"We can see our forests vanishing, our water-powers going to waste, our soil being carried by floods into the sea; and the end of our coal and our iron is in sight. But **our larger wastes of human effort**, which go on every day .... are less visible, less tangible, and are but vaguely appreciated."

Taylor (1911)

What Taylor wanted:

- Increase Productivity (elminate waste)
- High wages and Low labour cost (WIN -WIN)

What Taylor needed to deal with:

- Very low productivity
- Soldiering (taking it easy, working at low performance level)
- Great in-equalities
- Abundance of low-cost labour

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The Principles

- *First.* They develop a science for each element of a man's work, which replaces the old rule-of" thumb method.
- *Second.* They scientifically select and then train, teach, and develop the workman, whereas in the past he chose his own work and trained himself as best he could.
- *Third.* They heartily cooperate with the men so as to insure all of the work being done in accordance with the principles of the science which has been developed.
- *Fourth.* There is an almost equal division of the work and the responsibility between the management and the workmen. The management take over all work for which they are better fitted than the workmen, while in the past almost all of the work and the greater part of the responsibility were thrown upon the men.

The criticism: The biggest bastard ever!

Taylor's followers

- Gilbreth (1911): All human work can be reduced to 17 movements: Therbligs
  http://www.youtube.com/watch?v=lDg9REgkCQk
- Abuse of the system:(1914) US law prohibiting stopwatch time studies in all public businesses.
- Segur (1926): Motion-Time analysis
- Maynard, Schwab and Stegemerten (1948): MTM-1

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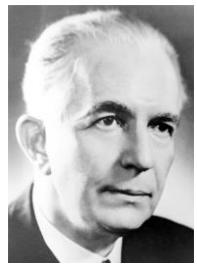
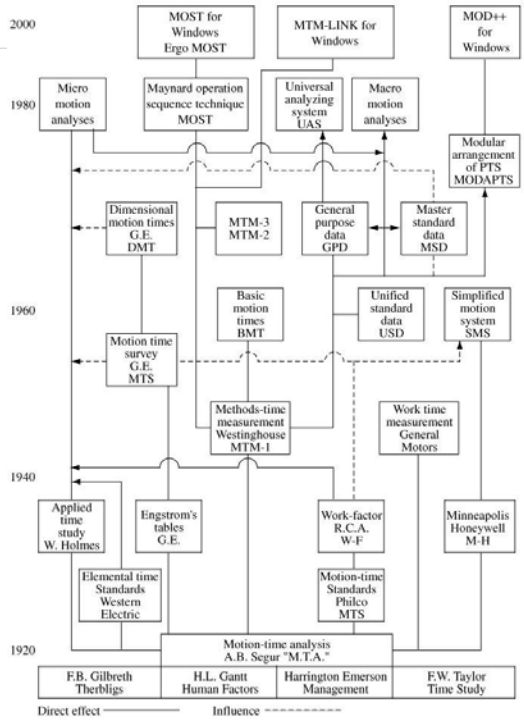
MTM-1



Assar Gabrielsson

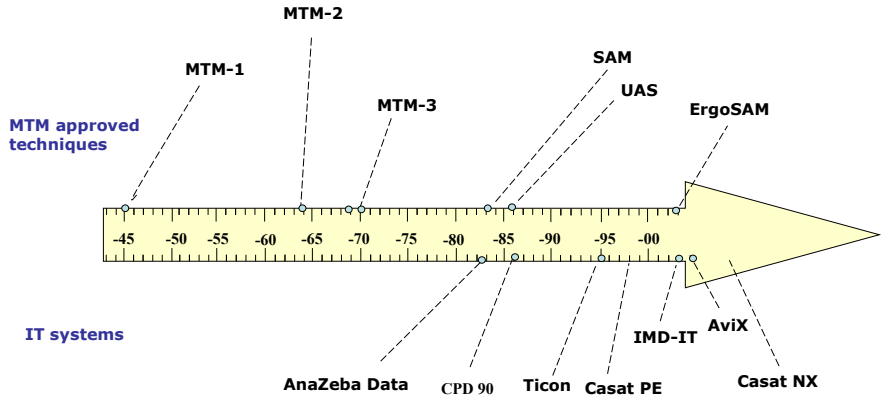
H B Maynard

FIG. 26.—Transport empty (right hand).



Freivalds "Niebel's Methods, standards, and Work Design"

Analysis techniques System development



International MTM Directorate

- Maintaining the standard
- MTM-1 and MTM-2
- Approved high level: UAS and SAM (not MOST !)

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Time Measurement Unit - TMU

TMU	Seconds	Minutes	Hours
1	0,036	0,0006	0,00001
100	3,6	0,06	0,001
28	1		
1667	60	1	

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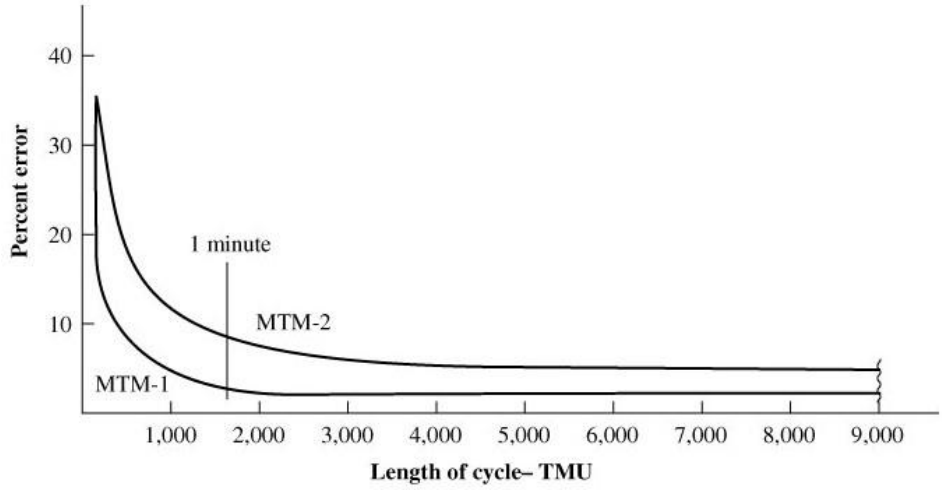

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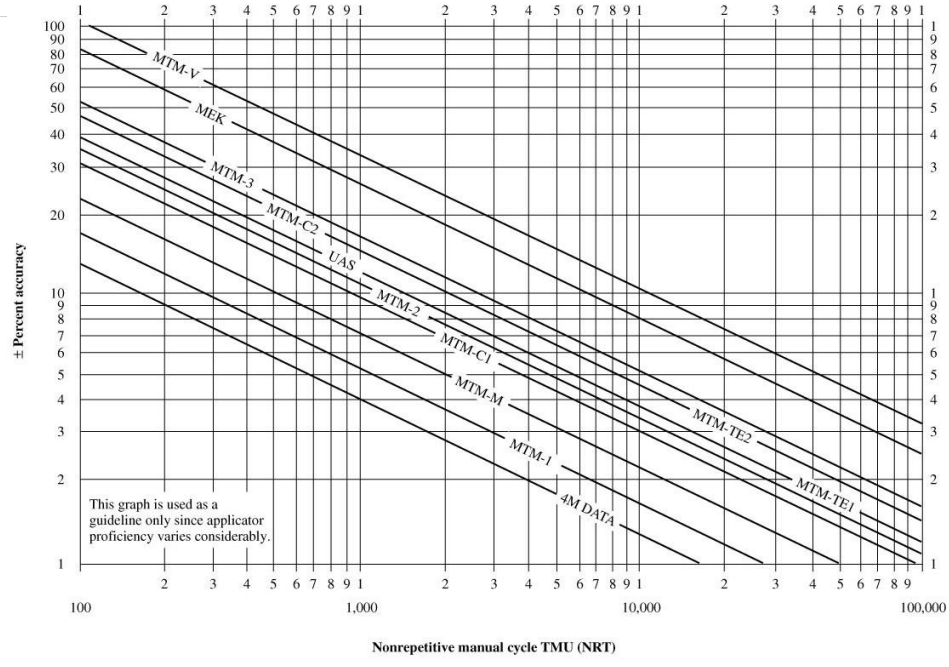

MTM-1 (Therbligs)

- Reach – R
  - Example: R20B = Reach 20 inches to an object in location that may vary slightly.
- Move – M
  - Distance, weight, and precision affects.
- Turn – T
- Apply pressure - AP

MTM-1 (Therbligs cont.)

- Grasp – G
  - Easy to hard (interference or small size)
- Position – P
- Release – R
- Disengage – D
- Eye travel – ET, Eye focus – EF
- Body, leg, and foot motions

Simultaneous motions

- Always separation left and right hand motion.
- Rules for possible combinations of simultaneous motions.

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MTM-2

- Single basic MTM-1 motions
- Combinations of MTM-1 motions

- Use when
  - The effort portion of the work cycle is more than one minute.
  - The cycle is not highly repetetive.
  - No complex simultaneous motions.

MTM-2: 11 categories

- GET
- PUT
- GET Weight
- PUT Weight
- Regrasp
- Apply pressure
- Eye action
- Foot action
- Step
- Bend and arise
- Crank

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MTM-2 Simultaneous motions

Motion		GET			PUT		
	Case	GA	GB	GC	PA	PB O*W	PC
Get	GA					X X	X
	GB					X X	
	GC				X		
Put	PA					X X	X
	PB	X	X		X	X	
	PC	X			X		

Easy ☐ Practice ☒ Difficult ▭

*O = Outside; W = Within normal vision

MTM Methods Analysis Page of

Operation: T-SHIRT TURNING
Study No.: (MANUAL)
Date: 2-12-93
Analyst: AF

Remarks: MANUAL HANDLING
TOTAL OF 141 TMUs

Description	No.	LH	TMU	RH	No.	Description
GET T-SHIRT		GB18	18	GB18		GET T-SHIRT
REACH INSIDE, PINCH CLOTH		GC12	23	GC12		REACH INSIDE, PINCH CLOTH
SIMULTANEOUS MOTION		GC2	14	GC2		SIMULTANEOUS MOTION ALLOW.
PULL SLEEVE UP AND OUT		PC32	41	PC32		PULL SLEEVE UP AND OUT
SIMULTANEOUS MOTION ALLOW.		PC2	21	PC2		SIMULTANEOUS MOTION
SET T-SHIRT DOWN		PB18	24	PB18		SET T-SHIRT DOWN
			(141)			

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MOST – Maynard Operation Sequence Technique

Kjell Zandin, Scania, 1967

- Basic MOST (1-3 min)
- MiniMOST (< 1,6 min, > 1500 times/week)
- MaxiMOST (> 2 min, < 150 times/week)

UNIVERSAL ANALYZING SYSTEM - UAS

MTM-UAS was developed between 1976-78 by a consortium composed of:

Deutsche MTM Vereinigung
Swiss MTM Association
Austrian MTM -Group

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SAM

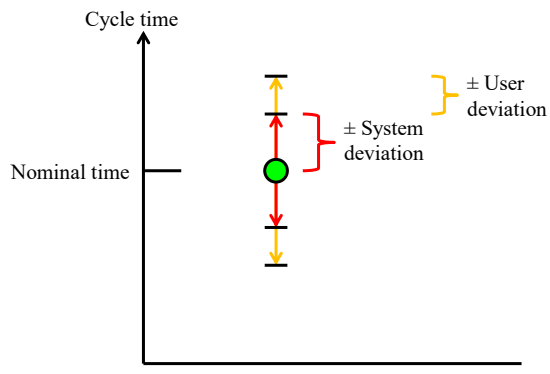
Sequential Activity and Method analysis

Most slides are made by Jonas Laring, Chalmers

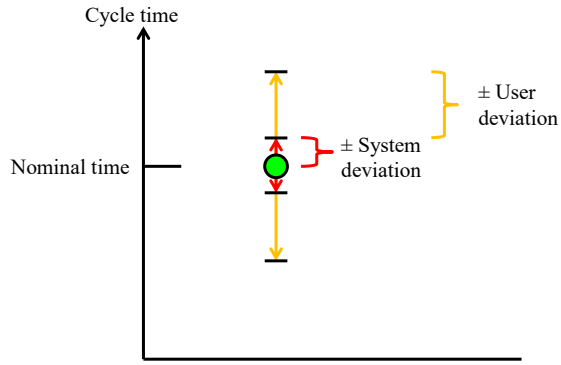
Design principles - SAM

1. Sequential analysis form GET + PUT + USE + RETURN
2. Minimize user deviation
   - Subjective decisions must be binary
   - Purpose based variables of GET resp. PUT, not behaviour based
   - Group or eliminate difficult decisions (on the expense of system deviation)
3. Accuracy is gained by specific Repetitive Sequences
4. No MTM pre-training requirement

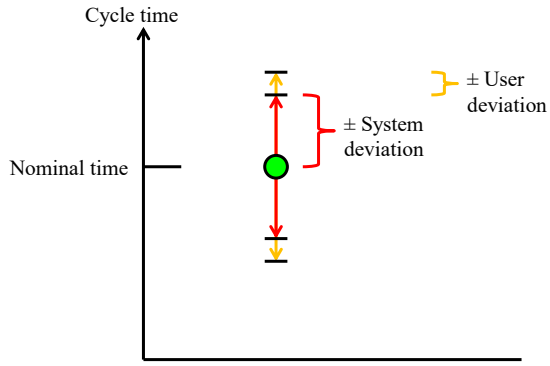
System and User deviation



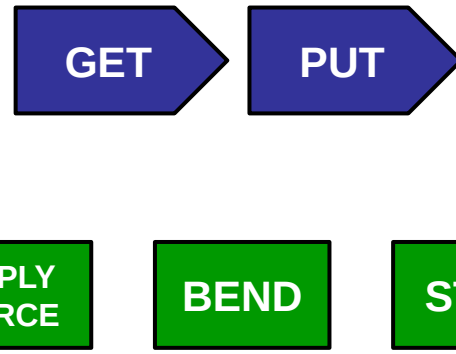
MTM-1


Cycle time
Nominal time
± System deviation
± User deviation

SAM


Cycle time
Nominal time
± System deviation
± User deviation

Sequence - Object handling



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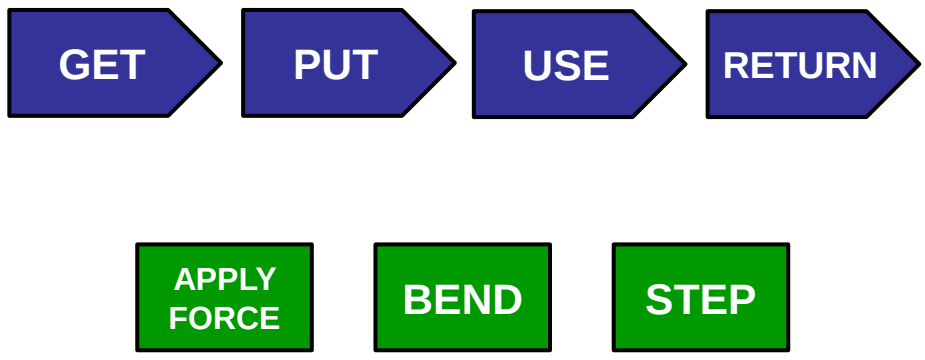
Sequence - Tool handling



Three categories of activities

Basic activities

GET (G)
PUT (P)

Supplementary activities

APPLY FORCE (AF)
STEP (S)
BEND (B)

Repetitive activities

SCREW (S)
CRANK (CA)
TO AND FROM (FA)
HAMMER (H)
READ (R)
NOTE (N)
PRESS BUTTON (PA)

Several activities can be specified further by **Variables.**

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SAM Analysis Form

	SAM Analysis Form	Reg.nr
Object	Date	DWG No.
Operation	Issued by	Page of

Method description	GET					PUT							USE				RETURN	PUT								Summing up Factors		
	Step	GS			Add. for Handful	Weight >5 kg	Step	PD			Add. for Precision	Apply Force	No.of strokes, grips etc..	No.of places	Time of stroke,prip etc		Apply Force	Weight > 5 kg	Step	PD			Add. for Precision	Apply Force	Bend+Arise			
	S	80	45	10	-H	AW	S	80	45	10	-P	AF					AF	AW	S	80	45	10	-P	AF	B			
	3	5	4	2	6	2	3	5	4	2	3	3	f	n	t	=	3	2	3	5	4	2	3	3	12	F	f	Total
	3	5	4	2	6	2	3	5	4	2	3	3					3	2	3	5	4	2	3	3	12			
	3	5	4	2	6	2	3	5	4	2	3	3					3	2	3	5	4	2	3	3	12			
	3	5	4	2	6	2	3	5	4	2	3	3					3	2	3	5	4	2	3	3	12			
	3	5	4	2	6	2	3	5	4	2	3	3					3	2	3	5	4	2	3	3	12			
	3	5	4	2	6	2	3	5	4	2	3	3					3	2	3	5	4	2	3	3	12			
	3	5	4	2	6	2	3	5	4	2	3	3					3	2	3	5	4	2	3	3	12			
	3	5	4	2	6	2	3	5	4	2	3	3					3	2	3	5	4	2	3	3	12			
	3	5	4	2	6	2	3	5	4	2	3	3					3	2	3	5	4	2	3	3	12			
	3	5	4	2	6	2	3	5	4	2	3	3					3	2	3	5	4	2	3	3	12			
	3	5	4	2	6	2	3	5	4	2	3	3					3	2	3	5	4	2	3	3	12			

Calculation:	Total net time (factors)	

GET (G) has two variables

- Movement distance – **Distance groups**
  - **10 =** 0 ≤ 10 cm
  - **45 =** > 10 ≤ 45 cm
  - **80 =** > 45 – incl. a supporting step
- **Number of objects**
  - single = **GS**
  - handful = **GH**

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PUT (P) has three variables

- Weight of the object – **Weight allowance** when the weight is more than 5 kg = **AW**
- Movement distance – **Distance groups**
  - **10 =** 0 ≤ 10 cm
  - **45 =** > 10 ≤ 45 cm
  - **80 =** > 45 – incl. a supporting step
- **Degree of precision**
  - without precision (direct) = **PD**
  - with precision (precise) = **PP**

Apply PP if assembly (with some difficulty) or place within 2mm tolerance.

PP includes for example “enter thread” or movement in assembly direction of < 10 cm.

Supplementary activities

- **APPLY FORCE (AF) is assigned when force must be applied in order to overcome a resistance.**
- **STEP (S) is applied when the distance group 80 is insufficient for a GET or PLACE.**
- **BEND (B) is applied when the trunk is bent to a level where the hands reach down to or below knee level and subsequent arias again.**

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Repetitive activities

• SCREW	S
• CRANK	CA
• TO AND FROM	FA
• HAMMER	H
• READ	R
• NOTE	N
• PRESS BUTTON	PA

Time units

The time unit in SAM is called **Factor.**

1 factor…….	= 1/20 000 hour
1 TMU……..	= 1/100 000 hour
1 factor…….	= 5 TMU
3 factors……..	= 1 cmin = 1/100 min
333 factors……...	= 1 min
5,6 factors……	= 1 second
20 factors…….	= 1 mh = 1/1000 hour
20.000 factors……..	= 1 hour

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Basic activities		Movement distance in cm		
		≤10	>10 ≤45	>45
Activity	Code	**10**	**45**	**80**
GET single	**GS**	2	4	5
GET handful	**GH**	8	10	11
PLACE direct	**PD**	2	4	5
PLACE precise	**PP**	5	7	8
Allowance			Code	Time
PLACE with weight – weight allowance			**AW**	2

Supplementary activities	Code	Time
APPLY FORCE	**AF**	3
STEP	**S**	3
BEND	**B**	12

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GET (G)

- **Begins** when the hand or fingers start their movement towards the object(s) and **ends** when the hand or fingers have gained such control of the object(s) that the following SAM activity can begin.
- **Includes** all grasp motions that are needed to gain control over the objects and also the motions that releases the control over the object(s).
- Two variables: **Movement distance** and **Number of objects.**

PUT (P)

- **Begins** when the hand or the fingers start the movement of the object(s) towards the final position and **ends** when the object(s) have been placed in the final position.
- **Includes** movements and all adjustments of the grasp, changes of the direction of the movement, transfers of the object(s) from one hand to the other and corrections necessary to obtain the final position.
- Three variables: **Weight, Movement distance** and **Precision.**

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Repetitive activities

Repetitive activities		Thread diameter			
SCREW per grip with	Code	≤4 **4**	>4 ≤7 **7**	>7 ≤15 **15**	>15 ≤26 **26**
Fingers, light	**SA**	2	2	3	3
Fingers, resistance	**SB**	3	3	4	5
Screw driver, light	**SC**	2	3	4	-
Screw driver, resistance	**SD**	3	4	5	-
Yankee driver	**SE**	3	3	-	-
Ratchet wrench	**SF**	3	4	5	7
Ordinary wrench	**SG**	6	8	10	12
Allen key	**SH**	3	4	6	8
T-wrench	**SI**	6	7	8	10

Repetitive activities

Repetitive activities				
		Length cm in one direction		
		≤10	>10 ≤45	>45
TO AND FROM	Code	**10**	**45**	**80**
	FA	2	5	7

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Repetitive activities

Repetitive activities	Code	Time
HAMMER – per stroke		
Light with wrist	**HA**	2
Heavy with forearm	**HB**	4
READ – per term		
Read a term	**RA**	2
Read, compare terms	**RB**	7
Read a scale	**RC**	8
Control	**RD**	3
NOTE – per letter, digit		
Block letters	**NA**	5
Ordinary writing	**NB**	3
CRANK – per revolution	**CA**	3
PRESS BUTTON – per button	**PA**	2

Use of automatic tool

- Electric or pneumatic screwdrivers etc.
- Place the machine on bolt is PP.
- Secure the grip and push button to start is AF.
- Machine time (MT) is calculated or estimated.

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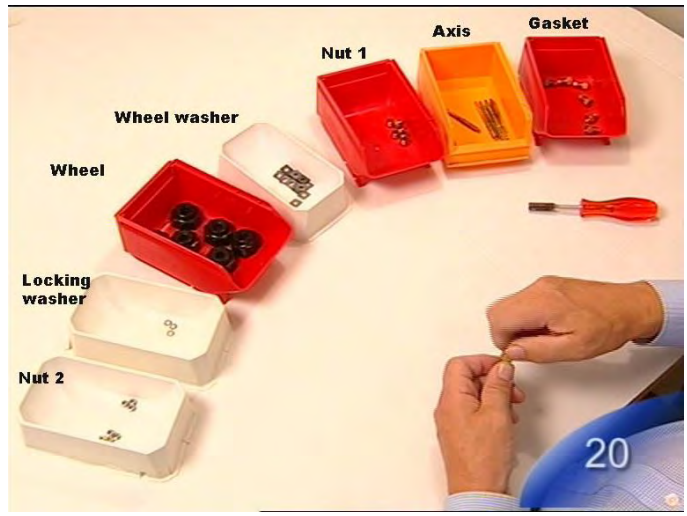
Exercise



SAM Analysis Form

Reg.nr

Object | Date | DWG No.

Operation | Issued by | Page of

Method description	GET				PUT					USE				RETURN						Summing up		
		GS				PD				No.of strokes, grips etc.	No.of places	Time of stroke,prip etc			PD					Factors		
	Step	80	45	10	Add. for Handful	Weight >5 kg	Step	80	45	10	Add. for Precision	Apply Force					Weight > 5 kg	Step	80	45	10	Add. for Precision	Apply Force	Bend-Arise			
	S				-H	AW	S				-P	AF	f	n	t	=	AF	AW	G			-P	AF	B	F	f	Total
	3	5	4	2	6	2	3	5	4	2	3	3					3	2	3	5	4	2	3	3	12			
Put gasket in left hand			4						4																	8	1	8
Put axis in gasket			4						4																	8	1	8
Assemble nut on axis			4						4		3		6	1	3	SA15												
			4						4		3					18										29	1	29
Assemble wheel washer 1 on axis			4						4		3															11	1	11
Assemble wheel on axis			4						4		3															11	1	11
Assemble wheel washer 2 on axis			4						4		3															11	1	11
Assemble locking washer			4						4		3															11	1	11
Assemble nut on axis			4						4		3															11	1	11
Use screwdriver to tighten nut			4						4		1		8	1	2	SC4										25	1	25
Check and put away assembly			4								3					16										7	1	7
Calculation:																	Total net time (factors)											132

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Learning objectives

- After this lecture the students will be able to…
  - Explain the historical development of PTS
  - Motivate the use of PTS
  - Select appropriate PTS for the task depending on length of work cycle and type of work
  - Use the SAM method