OPERATIONS ANALYSIS.

Method Study

OPERATIONS ANALYSIS

- A technique for accomplishing the goal of methods engineering
- An investigative process dealing with process in factory or office.
- Usually the process leads to operation standardization
- This is then followed by work measurement

Flow Process Chart

Figure 10.5 (c)

Present Method ☐ PROCESS CHART

Proposed Method ☒

SUBJECT CHARTED Axle-stand Production DATE 8 / 1 / 05

CHART BY JH

CHART NO. 1

DEPARTMENT Work cell for axle stand SHEET NO. 1 OF 1

DIST. IN FEET	TIME IN MINS.	CHART SYMBOLS	PROCESS DESCRIPTION
50			From press machine to storage bins at work cell
	3		Storage bins
5			Move to machine 1
	4		Operation at machine 1
4			Move to machine 2
	2.5		Operation at machine 2
4			Move to machine 3
	3.5		Operation at machine 3
4			Move to machine 4
	4		Operation at machine 4
20			Move to welding
	Poka-yoke		Poka-yoke inspection at welding
	4		Weld
10			Move to painting
	4		Paint
97	25		TOTAL

= operation; = transportation; = inspection; = delay; = storage

Flow Diagram

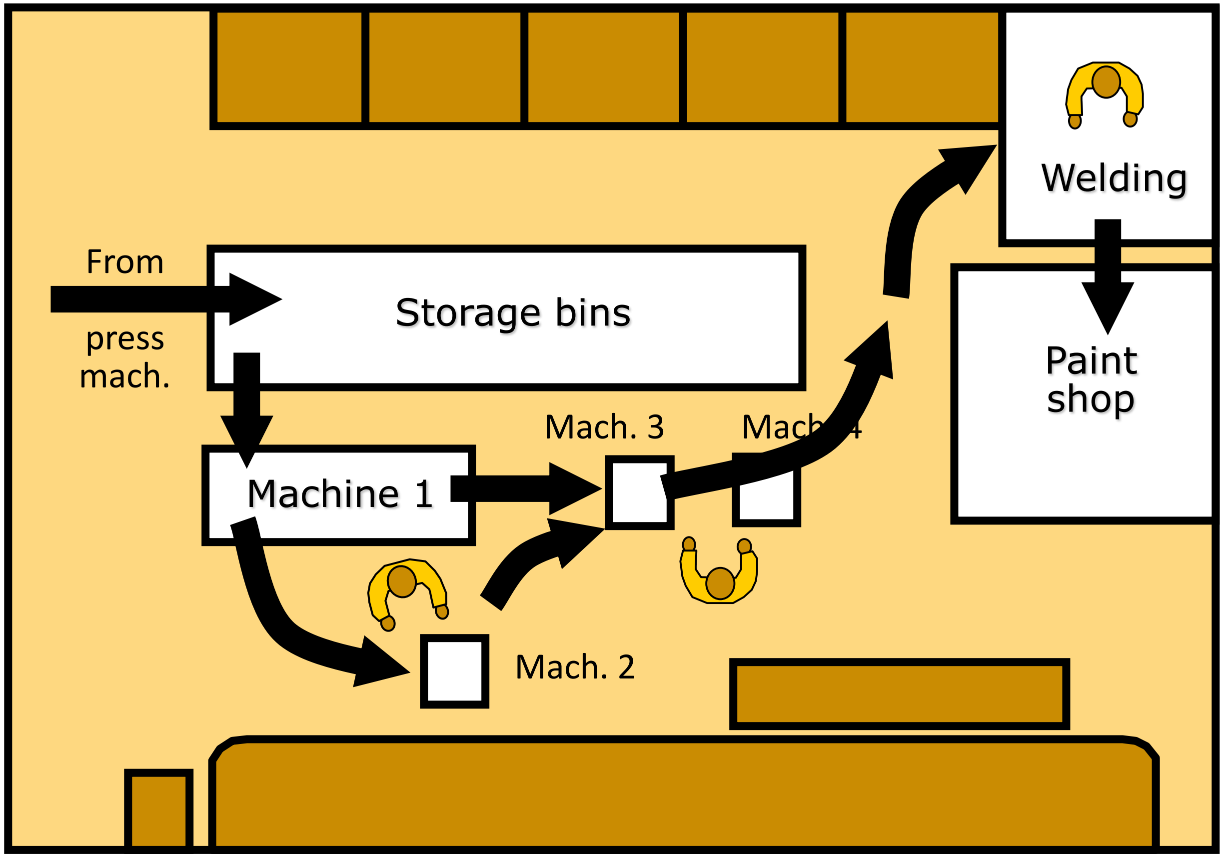


Figure 10.5 (a)

Flow Diagram

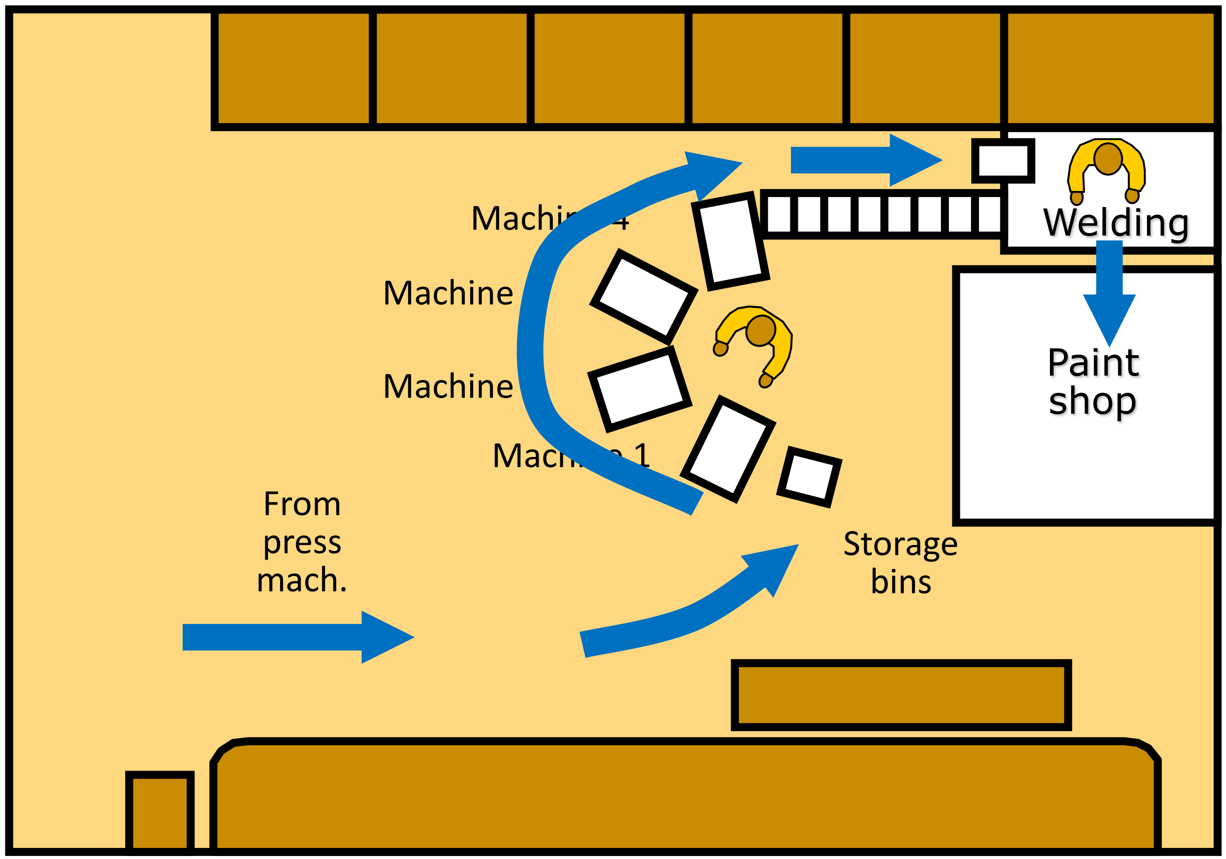
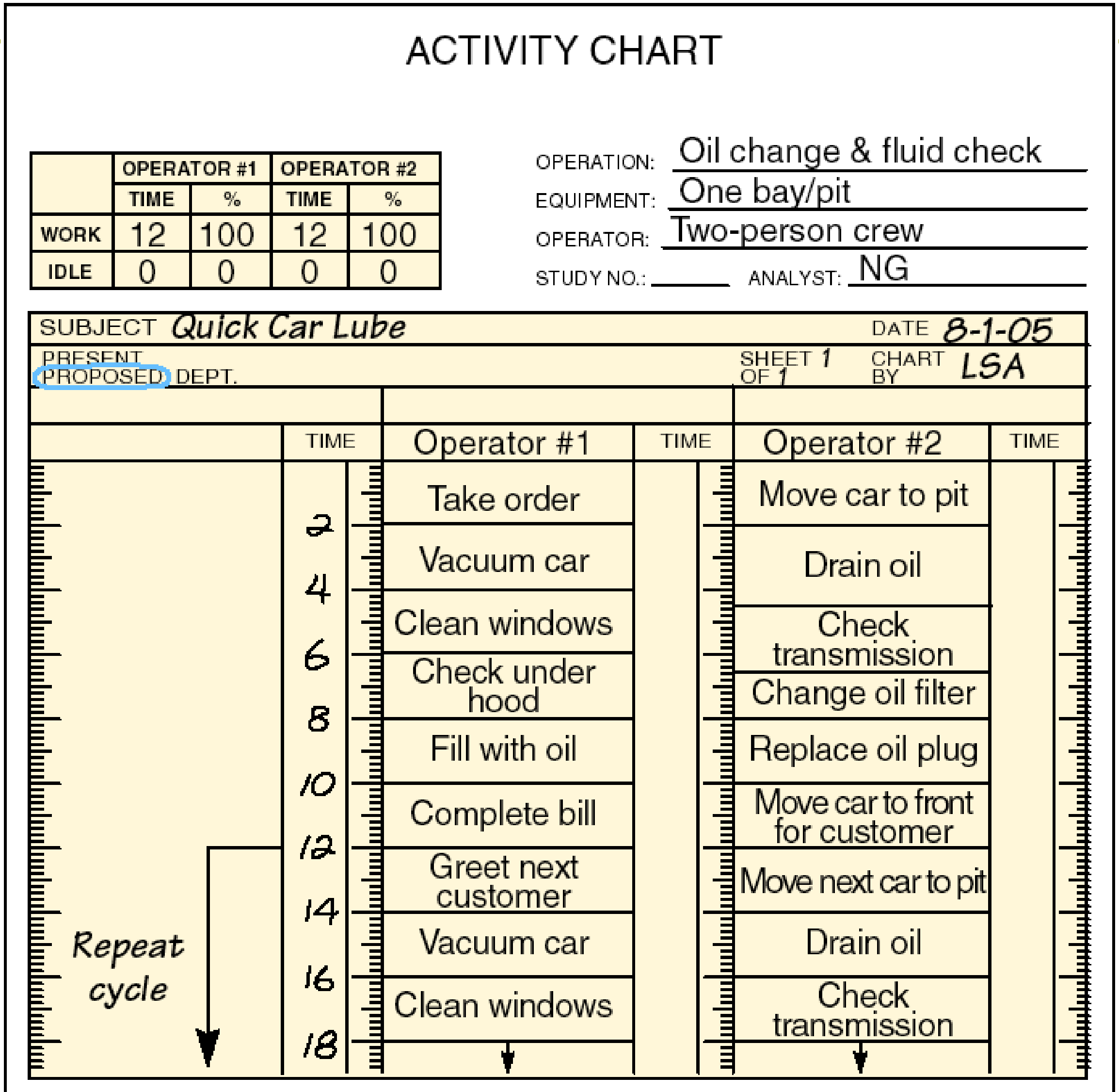


Figure 10.5 (b)

Activity Chart



ACTIVITY CHART

	OPERATOR #1		OPERATOR #2	
	TIME	%	TIME	%
WORK	12	100	12	100
IDLE	0	0	0	0

OPERATION: Oil change & fluid check
EQUIPMENT: One bay/pit
OPERATOR: Two-person crew
STUDY NO.:
ANALYST: NG

SUBJECT *Quick Car Lube* DATE *8-1-05*
PRESENT
PROPOSED DEPT. SHEET *1* OF *1* CHART BY *LSA*

TIME	Operator #1	TIME	Operator #2	TIME
2	Take order		Move car to pit	
4	Vacuum car		Drain oil	
6	Clean windows		Check transmission	
8	Check under hood		Change oil filter	
10	Fill with oil		Replace oil plug	
12	Complete bill		Move car to front for customer	
14	Greet next customer		Move next car to pit	
16	Vacuum car		Drain oil	
18	Clean windows		Check transmission	

Repeat cycle

Figure 10.6

Operator Process Chart

OPERATION CHART

SYMBOLS	PRESENT LH	PRESENT RH	PROPOSED LH	PROPOSED RH
○ OPERATION	2	3		
⇨ TRANSPORT.	1	1		
□ INSPECTION				
D DELAY	4	3		
▽ STORAGE				

PROCESS: Bolt–washer assembly
EQUIPMENT:
OPERATOR: KJH
STUDY NO: ANALYST:
DATE: 8 /1 /05 SHEET NO. 1 of 1
METHOD (PRESENT / PROPOSED)
REMARKS:

LEFT-HAND ACTIVITY Present METHOD	DIST.	SYMBOLS	SYMBOLS	DIST.	RIGHT-HAND ACTIVITY Present METHOD
1 Reach for bolt		○⇨□D▽	○⇨□D▽		Idle
2 Grasp bolt		○⇨□D▽	○⇨□D▽		Idle
3 Move bolt	6″	○⇨□D▽	○⇨□D▽		Idle
4 Hold bolt		○⇨□D▽	○⇨□D▽		Reach for washer
5 Hold bolt		○⇨□D▽	○⇨□D▽		Grasp washer
6 Hold bolt		○⇨□D▽	○⇨□D▽	8″	Move washer to bolt
7 Hold bolt		○⇨□D▽	○⇨□D▽		Place washer on bolt

Figure 10.7

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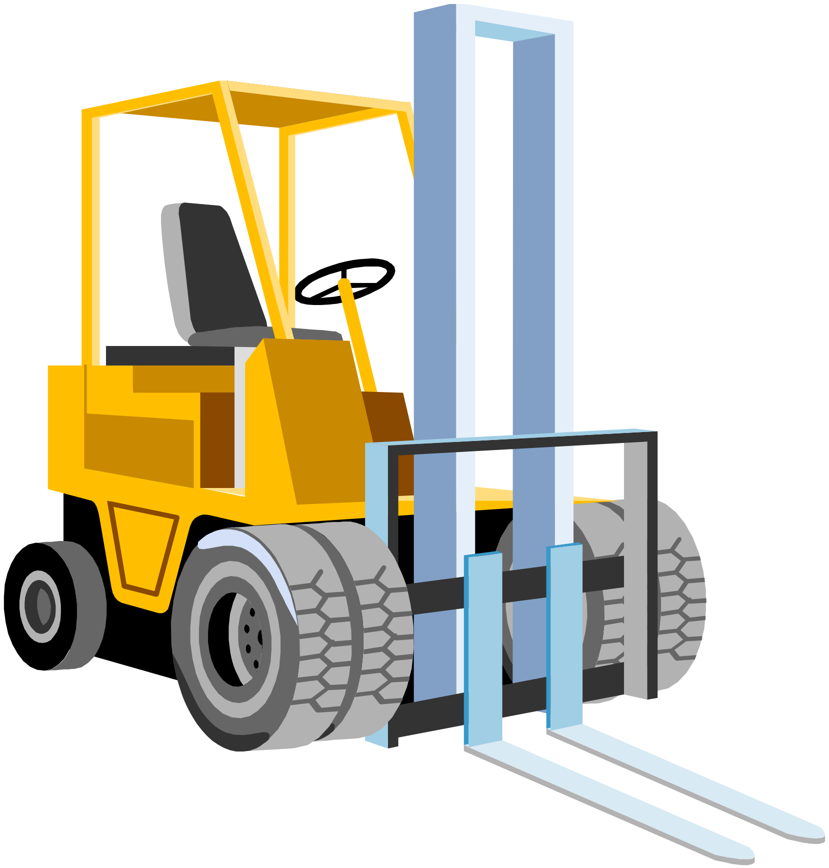
OPERATIONS ANALYSIS

- There are 10 major considerations of operation analysis that are applied in methods study.
- These are listed in the order in which they usually are considered:



major considerations of operation analysis

- purpose of operation,
- design of part,
- tolerances and specifications,
- material,
- process of manufacture,
- setup and tools,
- material handling,
- plant layout,
- working conditions, and
- motion study.

Process Charts

- Where work has not previously been studied, methods engineers repeatedly find that much of what is being done is entirely unnecessary.
- Sometimes whole operations are eliminated merely by asking why something is being done, and recognizing that there is no sound answer.
- The primary technique used to discover such situations is through the analysis of the process charts.

purpose of operation

- Probably the most important of the ten points
- Sometimes whole operations are eliminated merely by asking why something is being done, and recognizing that there is no sound answer.
- Eliminate or combine operations before attempting to improve it.

design of the part

- objective is to discover manufacturing economics, which the design engineer may have overlooked such as:
- Reducing number of parts - simplifying the design
- Utilizing a better material that improves manufacturing or cost

tolerances and specifications

- A look at tolerances & specifications will often suggest better ways of obtaining necessary quality and product reliability without increase in cost.

materials

- Materials of which the product is made and the way the materials are supplied and used in performing the operations required to produce the product if looked at will frequently lead to savings.

process of manufacture

- A process that is best today may not be best tomorrow because of improved technology.

tooling and setup procedures

- The larger the quantity to be produced, the more advanced should be the tooling. As quantity requirements change, existing setup and tooling may become inefficient.

- improving jigs or fixtures by providing ejectors and quick-acting clamps

material handling

- Within a factory or other enterprise, handling of material adds to the cost of a product without adding to its saleable value. Therefore material handling should be eliminated or minimised.
- install gravity delivery chutes;
- use drop delivery where applicable

layout

- Work stations and facilities, including service facilities, should be arranged to permit the least travel and the most efficient processing of a product with a minimum of handling.
- change layouts to eliminate backtracking
- permit coupling of machines;

working conditions

- The methods analyst will study the working conditions of each work centre for possibilities for job improvement:

e.g. providing the correct chair for each operator;

using foot-operated mechanisms;

arranging tools and parts within normal working areas;

providing correct light, ventilation, temperature, and safety features for the operator.

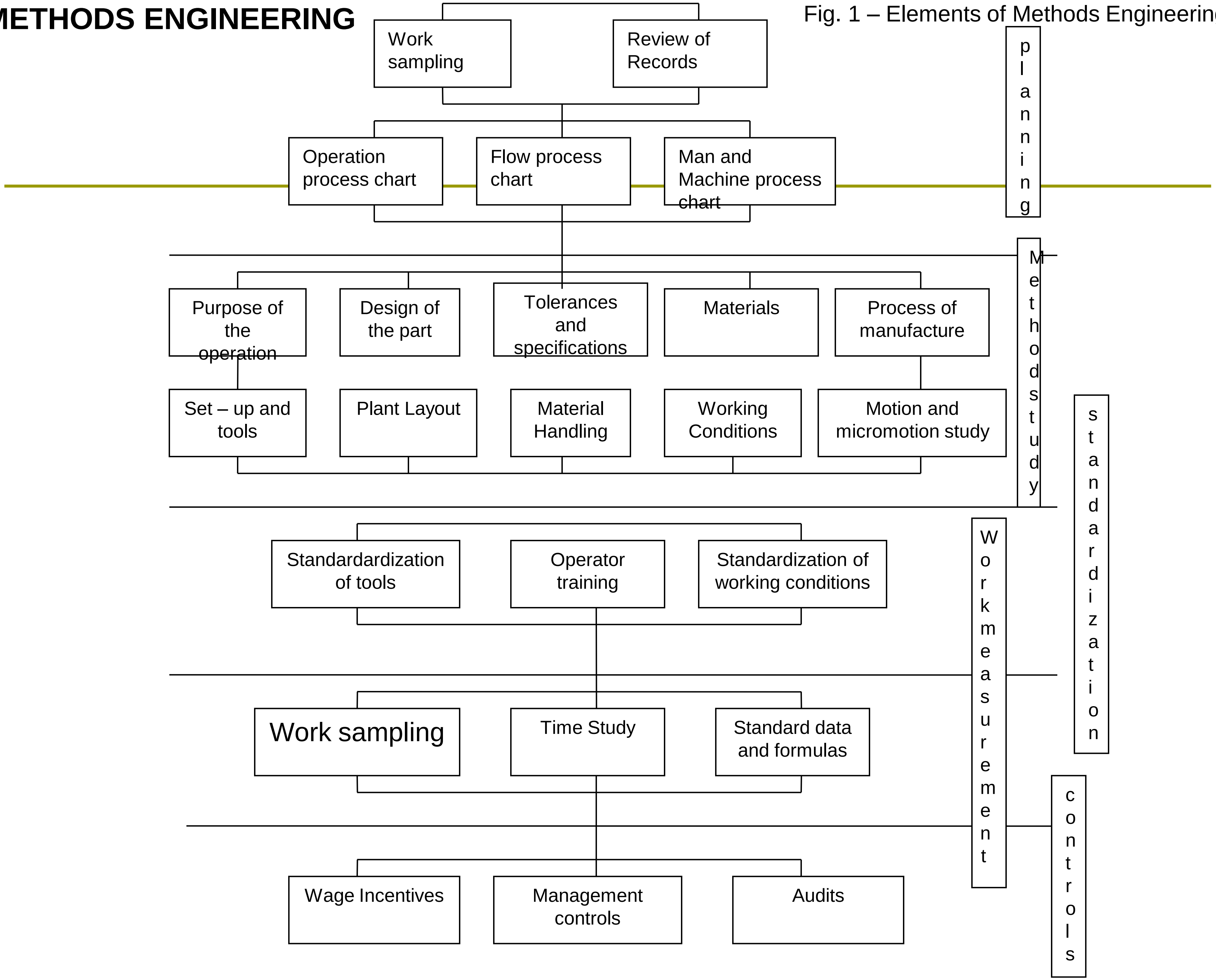
motion study

- involves the study of both manual and eye movements that occur in an operation or work cycle in order to eliminate wasted movements and establish a better sequence and co-ordination of movements

- arranging for two-handed operations

METHODS ENGINEERING

Fig. 1 – Elements of Methods Engineering



WORK MEASUREMENT

- Work Measurement establishes the work content of a job.
- It determines the time that it takes to do a job or perform a method.
- It is necessary for management planning and controls.

Work measurement – determination of labour standards

- Work measurement is the process which establishes the time it should take to perform a precise task under given conditions, employing a given method and given tools and equipment when working at a normal work pace, this known as standard time
- Time study analyst make measurement to obtain the following:
  - The time actually taken by the operator to perform the task
  - The measure of the worker’s actual work pace compared to his concept of normal pace

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Labor Standards

May be set in four ways:

1. Historical experience
2. Time studies
3. Predetermined time standards
4. Work sampling

Historical Experience

- ☑ How the task was performed last time
- ☑ Easy and inexpensive
- ☑ Data available from production records or time cards
- ☑ Data is not objective and may be inaccurate
- ☑ Not recommended

Stopclock Time Studies

- ☑ Involves timing a sample of a worker’s performance and using it to set a standard
- ☑ Requires trained and experienced observers
- ☑ Cannot be set before the work is performed

Stopclock Time Studies

1. Stopwatch time study- in this technique, the times and rates of working for the job elements carried out under specified conditions are recorded and data analysed so as to determine the time necessary for carrying out the job at a defined level of performance

- Stopwatch study consist of the following:
  - Define the task to be studied
  - Break the job down into elements
  - Time the job elements
  - Determine the number of observations to make
  - Rate the worker's performance
  - Determine the standard time

Stopclock Time Studies

5. Compute average cycle time

$$\text{Average observed cycle time} = \left(\frac{\text{sum of the times recorded to perform each element}}{\text{number of cycles observed}} \right)$$

6. Determine performance rating and normal time

$$\text{Normal time} = \left(\text{average observed cycle time} \right) \times \left(\text{performance rating factor} \right)$$

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Time Studies

7. Add all the normal times for each element to develop the total normal time for the task

8. Compute the standard time

$$\text{Standard time} = \frac{\text{total normal time}}{1 - \text{allowance factor}}$$

Rest Allowances

- ☑ Personal time allowance
  - ☑ 4% - 7% of total time for use of restroom, water fountain, etc.
- ☑ Delay allowance
  - ☑ Based upon actual delays that occur
- ☑ Fatigue allowance
  - ☑ Based on our knowledge of human energy expenditure

Rest Allowances - 2

1. Constant allowance
   (A) Personal allowance 5
   (B) Basic fatigue allowance 4
2. Variable allowances:
   (A) Standing allowance 2
   (B) Abnormal position
      (i) Awkward (bending) 2
      (ii) Very awkward (lying, stretching) 7

Rest Allowances - 3

(C)Use of force or muscular energy in lifting, pulling, pushing

Weight lifted (pounds)

20 ………………………………… 3

40………………………………… 9

60………………………………… 17

(D)Bad light:

(i) Well below recommended….2

(ii) Quite inadequate…………… 5

Rest Allowances - 4

(E) Atmospheric conditions (heat and humidity) ……………0-10

(F) Close attention:

(i) Fine or exacting………………. 2

(ii) Very fine or very exacting……5

(G) Noise level:

(i) Intermittent—loud……………. 2

(ii) Intermittent—very loud or high-pitched………………. 5

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Rest Allowances - 5

(H) Mental strain:

(i) Complex or wide span of attention.......................... 4

(ii) Very complex...................... 8

(I) Tediousness:

(i) Tedious.............................. 2

(ii) Very tedious....................... 5

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Time Study Example 1

Average observed time = 4.0 minutes
Worker rating = 85%
Allowance factor = 13%

Normal time = (average observed time) x (rating factor)

= (4.0)(.85)

= 3.4 minutes

$$\text{Standard time} = \frac{\text{normal time}}{1 - \text{allowance factor}} \quad \frac{3.4}{1 - .13} \quad \frac{3.4}{.87} =$$

= 3.9 minutes

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Time Study Example 2

Allowance factor = 15%

Job Element	Cycle Observed (in minutes) 1	2	3	4	5	Performance Rating
(A) Compose and type letter	8	10	9	21*	11	120%
(B) Type envelope address	2	3	2	1	3	105%
(C) Stuff, stamp, seal, and sort envelopes	2	1	5*	2	1	110%

1. Delete unusual or nonrecurring observations (marked with *)
2. Compute average cycle times for each element

Average time for A = (8 + 10 + 9 + 11)/4 = 9.5 minutes
Average time for B = (2 + 3 + 2 + 1 + 3)/5 = 2.2 minutes
Average time for C = (2 + 1 + 2 + 1)/4 = 1.5 minutes

Time Study Example 2

3. Compute the normal time for each element

Normal time = (average observed time) x (rating)

Normal time for A = (9.5)(1.2) = 11.4 minutes
Normal time for B = (2.2)(1.05) = 2.31 minutes
Normal time for C = (1.5)(1.10) = 1.65 minutes

4. Add the normal times to find the total normal time

Total normal time = 11.40 + 2.31 + 1.65 = 15.36 minutes

Time Study Example 2

5. Compute the standard time for the job

$$\text{Standard time} = \frac{\text{total normal time}}{1 - \text{allowance factor}}$$

$$= \frac{15.36}{1 - .15} \qquad = 18.07 \text{ minutes}$$

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Determination of Sample Size

- ☑ How accurate we want to be
- ☑ The desired level of confidence
- ☑ How much variation exists within the job elements

Determination of Sample Size

$$\text{Required sample size} = n = \left(\frac{zs}{h\bar{x}}\right)^2$$

where h = accuracy level desired in percent of the job element expressed as a decimal

z = number of standard deviations required for the desired level of confidence

s = standard deviation of the initial sample

$\bar{x}$ = mean of the initial sample

n = required sample size

Determine Sample Size

where

Common z Values

Desired Confidence (%)	z Value (standard deviation required for desired level of confidence)
90.0	1.65
95.0	1.96
95.45	2.00
99.0	2.58
99.73	3.00

Table S10.1

– Example 3

- Thoms Manufacturing Co. has asked you to check a labour standard prepared by a recently terminated methods analyst. Your first task is to determine the correct sample size. Your accuracy is to be within 5% and your confidence level at 95%. The standard deviation of the sample is 1.0 and the mean 3.00

Time Study Example 3

Desired accuracy with 5%
Confidence level = 95%
Sample standard deviation = 1.0
Sample mean = 3.00

$h = .05 \qquad \bar{x} = 3.00 \qquad s = 1.0$

$z = 1.96$ (from Table S10.1 or Appendix I)

$$n = \left(\frac{zs}{h\bar{x}} \right)^2$$

$$n = \left(\frac{1.96 \times 1.0}{.05 \times 3} \right)^2 = 170.74 \approx 171$$

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New Tools

With this PDA, you can study elements, time, performance rate, and statistical confidence intervals can be created, edited, managed, and downloaded to a spreadsheet

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Predetermined Time Standards

- ☑ Divide manual work into small basic elements that have established times
- ☑ Can be done in a laboratory away from the actual production operation
- ☑ Can be set before the work is actually performed
- ☑ No performance ratings are necessary

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MTM Table

GET and PLACE			DISTANCE RANGE IN IN.	<8	>8 <20	>20 <32
WEIGHT	CONDITIONS OF GET	PLACE ACCURACY	CODE	1	2	3
<2 LBS	EASY	APPROXIMATE	AA	20	35	50
		LOOSE	AB	30	45	60
		TIGHT	AC	40	55	70
	DIFFICULT	APPROXIMATE	AD	20	45	60
		LOOSE	AE	30	55	70
		TIGHT	AF	40	65	80
	HANDFUL	APPROXIMATE	AG	40	65	80
>2 LBS <18 LBS		APPROXIMATE	AH	25	45	55
		LOOSE	AJ	40	65	75
		TIGHT	AK	50	75	85
>18 LBS <45 LBS		APPROXIMATE	AL	90	106	115
		LOOSE	AM	95	120	130
		TIGHT	AN	120	145	160

Figure S10.2

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MTM Example

Weight - less than 2 pounds
Conditions of GET - easy
Place accuracy - approximate
Distance range - 8 to 20 inches

Element Description	*Element*	*Time*
Get tube from rack	*AA2*	35
Get stopper, place on counter	*AA2*	35
Get centrifuge tube, place at sample table	*AD2*	45
Pour (3 seconds)	*PT*	83
Place tubes in rack	*PC2*	40
	Total TMU	238

.0006 x 238 = *Total standard mins* = .14

Table S10.2

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Table S10.2

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Work Sampling

- ☑ Estimates percent of time a worker spends on various tasks
  - ☑ Less expensive than time study
  - ☑ Observers need little training
  - ☑ Studies can be delayed or interrupted with little impact on results
  - ☑ Worker has little chance to affect results
  - ☑ Less intrusive

Work Sampling

- ☑ Estimates percent of time a worker spends on various tasks
  - ☑ Does not divide work elements as completely as time study
  - ☑ Can yield biased results if observer does not follow random pattern
  - ☑ Less accurate than time study, especially when job element times are short

Work Sampling

1. Take a preliminary sample to obtain estimates of parameter values
2. Compute the sample size required
3. Prepare a schedule for random observations at appropriate times
4. Observe and record worker activities
5. Determine how workers spend their time

Work Sampling

Determining the sample size

$$n = \frac{z^2 \, p(1 - p)}{h^2}$$

where

- n = required sample size
- z = standard normal deviate for desired confidence level
- p = estimated value of sample proportion
- h = acceptable error level in percent

Work Sampling

Estimate employees idle 25% of the time
Sample should be accurate within 3%
Wants to have 95.45% confidence in the results

$$n = \frac{z^2\, p(1 - p)}{h^2}$$

where n = required sample size
z = 2 for a 95.45% confidence level
p = estimate of idle proportion = 25% = .25
h = acceptable error of 3% = .03

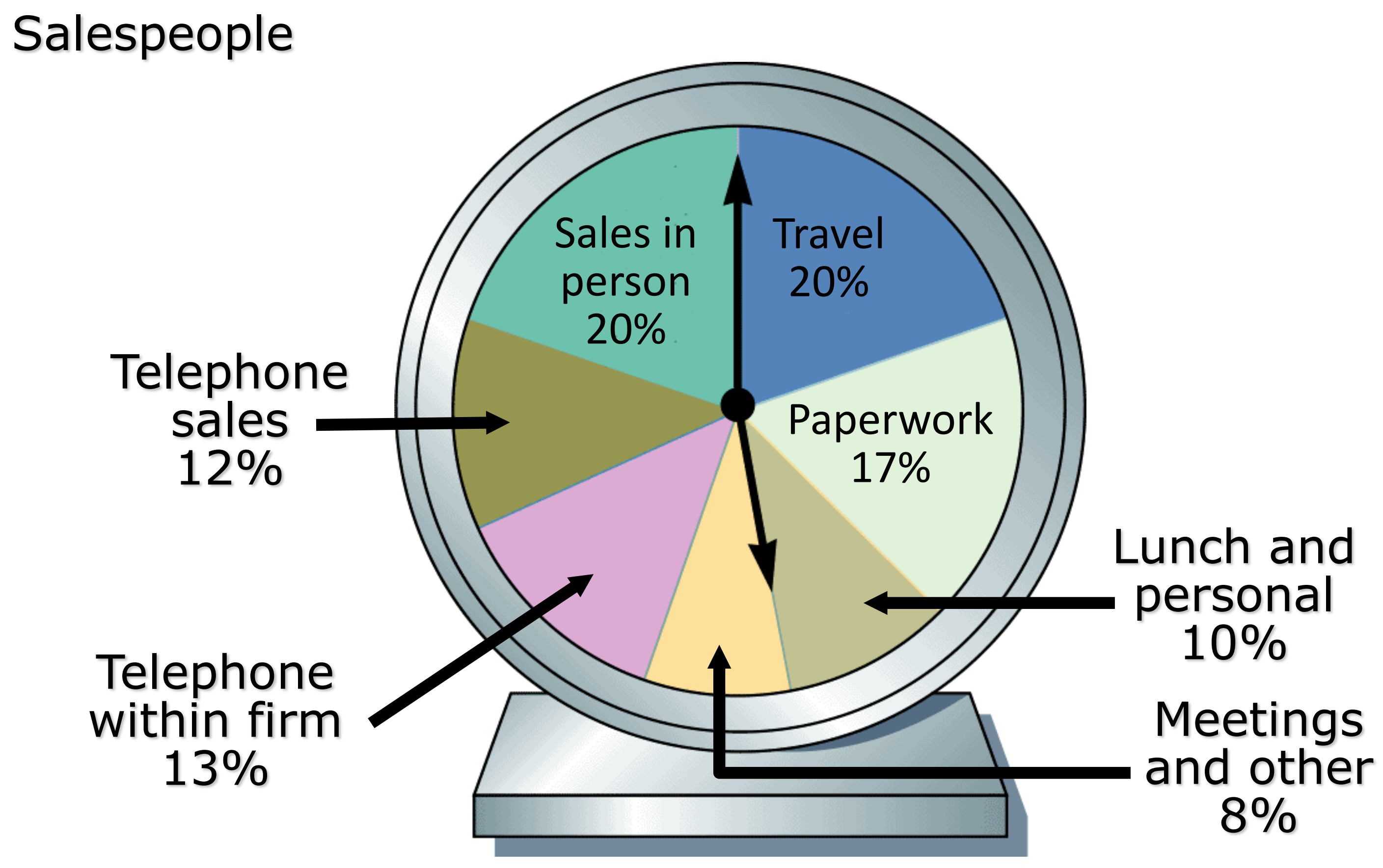
$$n = \frac{(2)^2\,(.25)(.75)}{(.03)^2} = 833 \text{ observations}$$

Work Sampling

No. of Observations	Activity
485	*On the phone or meeting with a welfare client*
126	*Idle*
62	*Personal time*
23	*Discussions with supervisor*
137	*Filing, meeting, and computer data entry*
833	

All but idle and personal time are work related. Percentage idle time = (126 + 62)/833 = 22.6%. Since this is less than the target value of 25%, the workload needs to be adjusted.

Work Sampling Time Studies



Uses of work measurement

- Production planning
- Product cost
- Determining manpower requirements
- Determining optimum number of machines to be tendered by an operator
- Designing incentives scheme

Compensation

- Wages have always been the basic reward for labour
- There are two types of wage payment plans available to employees
- Time-based payment provides for compensation of employees according to the time they devote to the organisation
- Incentive payments are made to reward workers for their output