Human Resources, Job Design, and Work Measurement

10

PowerPoint presentation to accompany
Heizer, Render, Munson
Operations Management, Twelfth Edition, Global Edition
Principles of Operations Management, Tenth Edition, Global Edition

PowerPoint slides by Jeff Heyl

Outline

- **Global Company Profile:**
  Rusty Wallace's NASCAR Racing Team
- Human Resource Strategy for Competitive Advantage
- Labor Planning
- Job Design
- Ergonomics and the Work Environment

Outline - Continued

- Methods Analysis
- The Visual Workplace
- Labor Standards
- Ethics

High-Performance Pit Crew

Teamwork Makes the Difference between Winning and Losing

- New century brought new popularity to NASCAR with increased sponsorship and prize money
- High performance pit crews are a key element of a successful race team

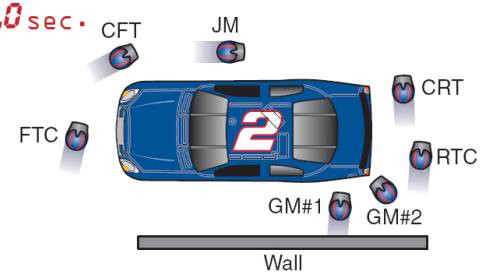
Rusty Wallace's NASCAR Racing Team

- Pit crew members can earn $100,000 per year – for changing tires!
- Each position has very specific labor standards
- Pit crews are highly organized and go through rigorous physical training
- Pit stops are videotaped to look for improvements

Rusty Wallace's NASCAR Racing Team

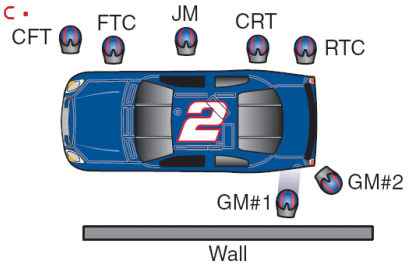
1 Wallace's car pulls into the pit; the crew rushes to the right side of the car to begin service.

0.0 sec.



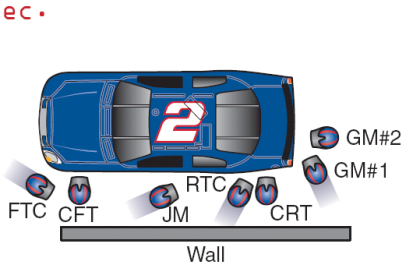
2 Right side is jacked up, tire starts to come off; gas man is emptying his first can.

3.1 sec.



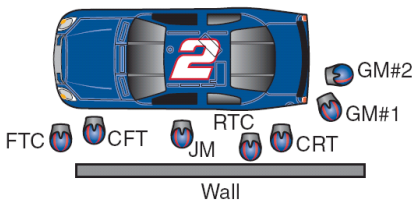
3 Action shifts to driver's side of the car; gas man carries second can of gas in.

8.9 sec.



4 The second can of gas is being emptied; driver's side tires are being changed.

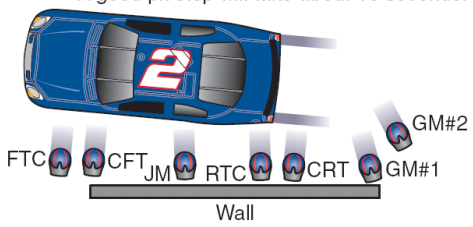
13.7 sec.



5 Service is complete. The jackman drops the car, which is the signal to the Wallace driver to exit the pit.

15.4 sec.

A good pit stop will take about 16 seconds.



Movement of the pit crew members who go over the wall...

JM = Jackman
FTC = Front tire carrier
CFT = Changer front tire
RTC = Rear tire carrier
CRT = Changer rear tire
GM#1 = Gas man #1
GM#2 = Gas man #2

Learning Objectives

When you complete this chapter you should be able to:

10.1 ***Describe*** labor-planning policies

10.2 ***Identify*** the major issues in job design

10.3 ***Identify*** major ergonomic and work environment issues

10.4 ***Use*** the tools of methods analysis

Learning Objectives

When you complete this chapter you should be able to:

10.5 ***Identify*** four ways of establishing labor standards

10.6 ***Compute*** the normal and standard times in a time study

10.7 ***Find*** the proper sample size for a time study

Human Resource Strategy

The objective of a human resource strategy is to manage labor and design jobs so people are effectively and efficiently utilized

Human Resource Strategy

- Ensure that people:

1. Are efficiently utilized within the constraints of other operations management decisions
2. Have a reasonable quality of work life in an atmosphere of mutual commitment and trust

Constraints on Human Resource Strategy

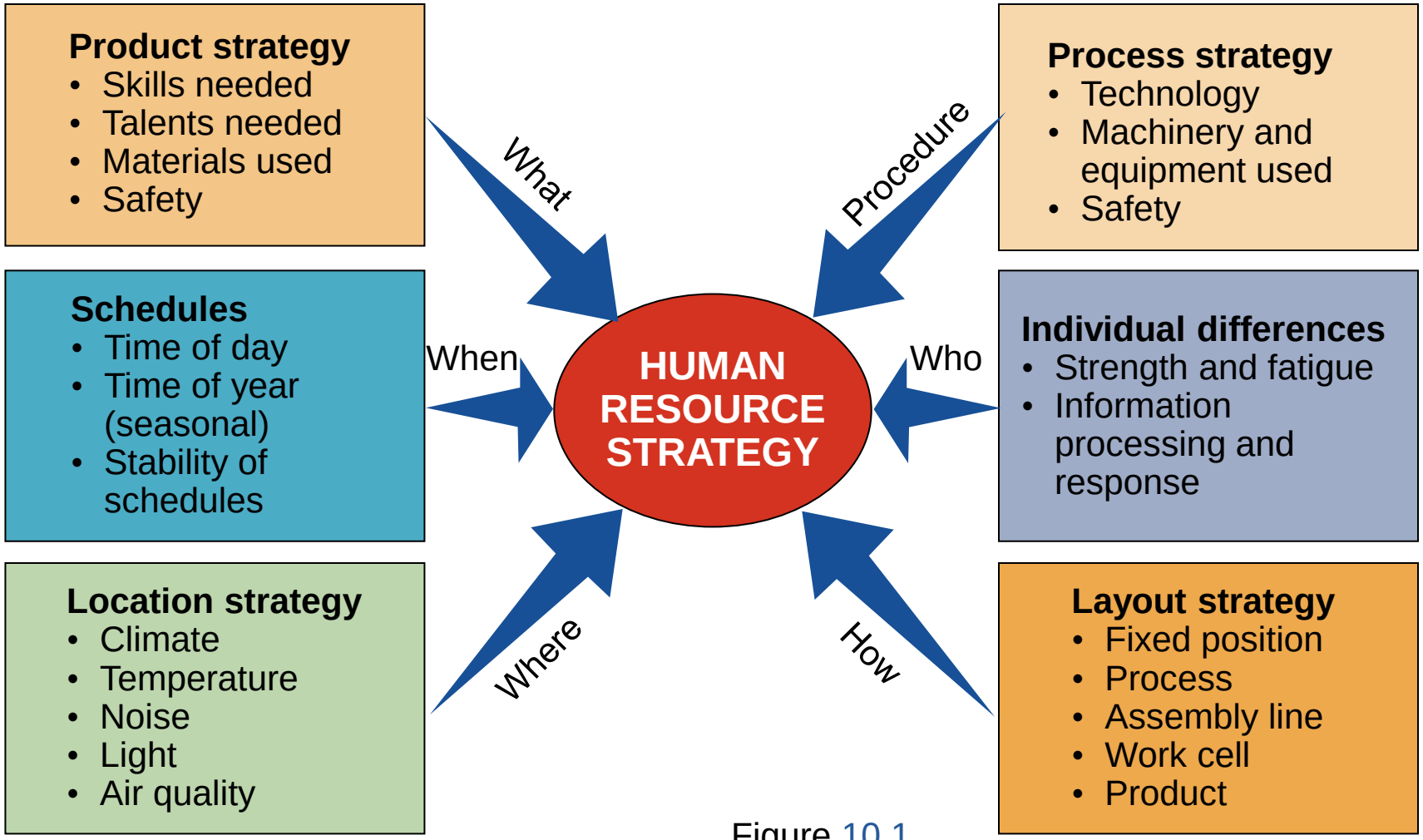


Figure 10.1

Labor Planning

Employment-Stability Policies

1. Follow demand exactly
   - Matches direct labor costs to production
   - Incurs costs in hiring and termination, unemployment insurance, and premium wages
   - Labor is treated as a variable cost

Labor Planning

Employment-Stability Policies

2. Hold employment constant
   - Maintains trained workforce
   - Minimizes hiring, layoff, and unemployment costs
   - Employees may be underutilized during slack periods or overworked during busy periods
   - Labor is treated as a fixed cost

Work Schedules

- Standard work schedule
  - Five eight-hour days
- *Flextime*
  - Allows employees, within limits, to determine their own schedules
- *Flexible work week/compressed workweek*
  - Fewer but longer days
- *Part-time status*
  - Fewer, possibly irregular, hours

Job Classification and Work Rules

- Specify who can do what
- Specify when they can do it
- Specify under what conditions they can do it
- Often result of union contracts
- Restricts flexibility in assignments and consequently efficiency of production

Job Design

- Specifying the tasks that constitute a job for an individual or a group
  1. Job specialization
  2. Job expansion
  3. Psychological components
  4. Self-directed teams
  5. Motivation and incentive systems

Labor Specialization

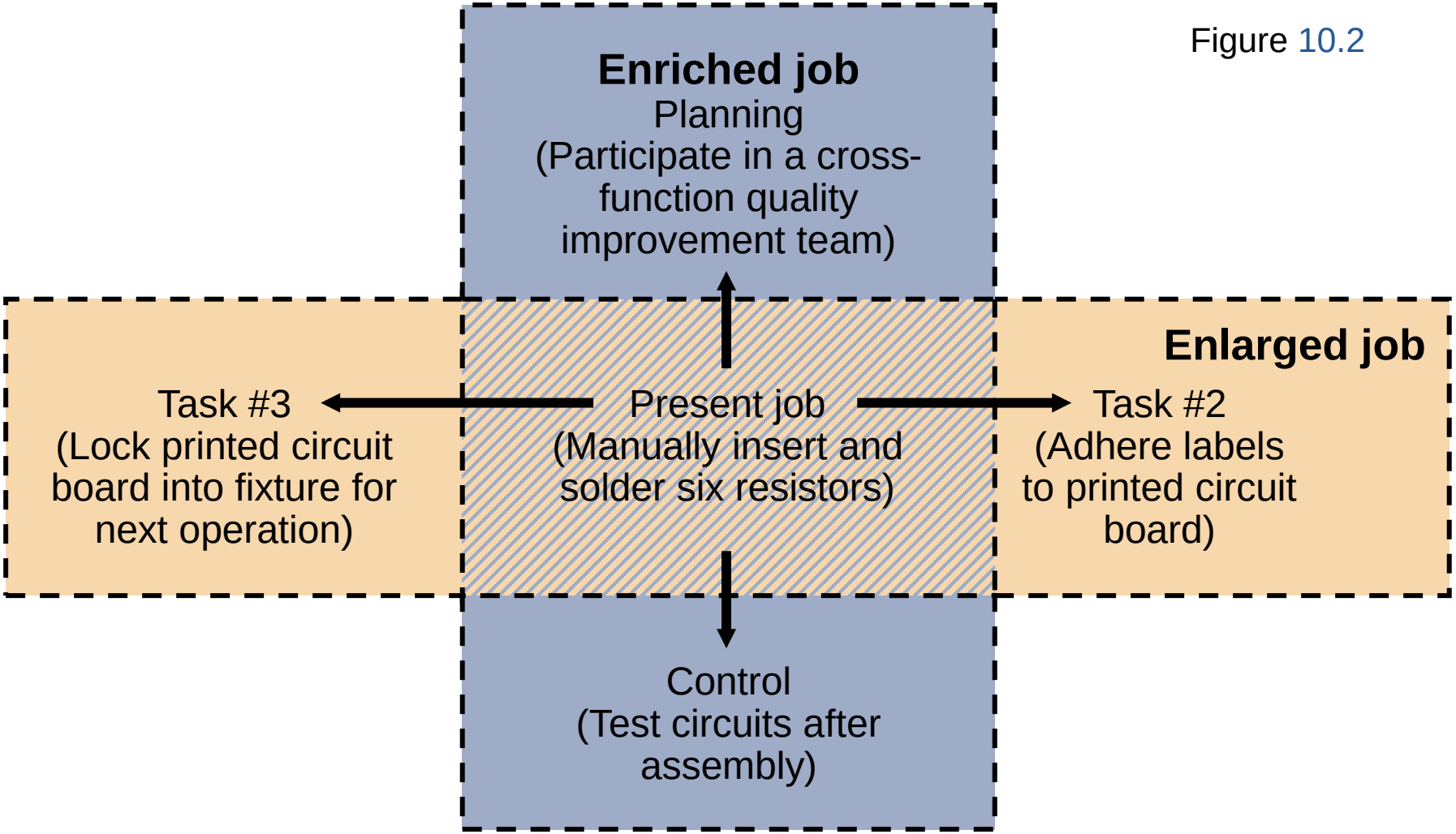
- The division of labor into unique tasks
- First suggested by Adam Smith in 1776
  1. *Development of dexterity*
  2. *Less loss of time*
  3. *Development of specialized tools*
- Later Charles Babbage (1832) added another consideration
  4. *Paying exactly the wage needed for the particular skill required*

Job Expansion

- Adding more variety to jobs
- Intended to reduce boredom associated with labor specialization
  - **Job enlargement**
  - **Job rotation**
  - **Job enrichment**
  - **Employee empowerment**

Job Enlargement

Figure 10.2



Psychological Components of Job Design

Human resource strategy requires consideration of the psychological components of job design

Hawthorne Studies

- They studied light levels, but discovered productivity improvement was independent from lighting levels
- Introduced psychology into the workplace
- The workplace social system and distinct roles played by individuals may be more important than physical factors
- Individual differences may be dominant in job expectation and contribution

Core Job Characteristics

Jobs should include the following characteristics

1. **Skill variety**
2. **Job identity**
3. **Job significance**
4. **Autonomy**
5. **Feedback**

Self-Directed Teams

- Group of empowered individuals working together to reach a common goal
- May be organized for long-term or short-term objectives
- Effective because
  - Provide employee empowerment
  - Ensure core job characteristics
  - Meet individual psychological needs

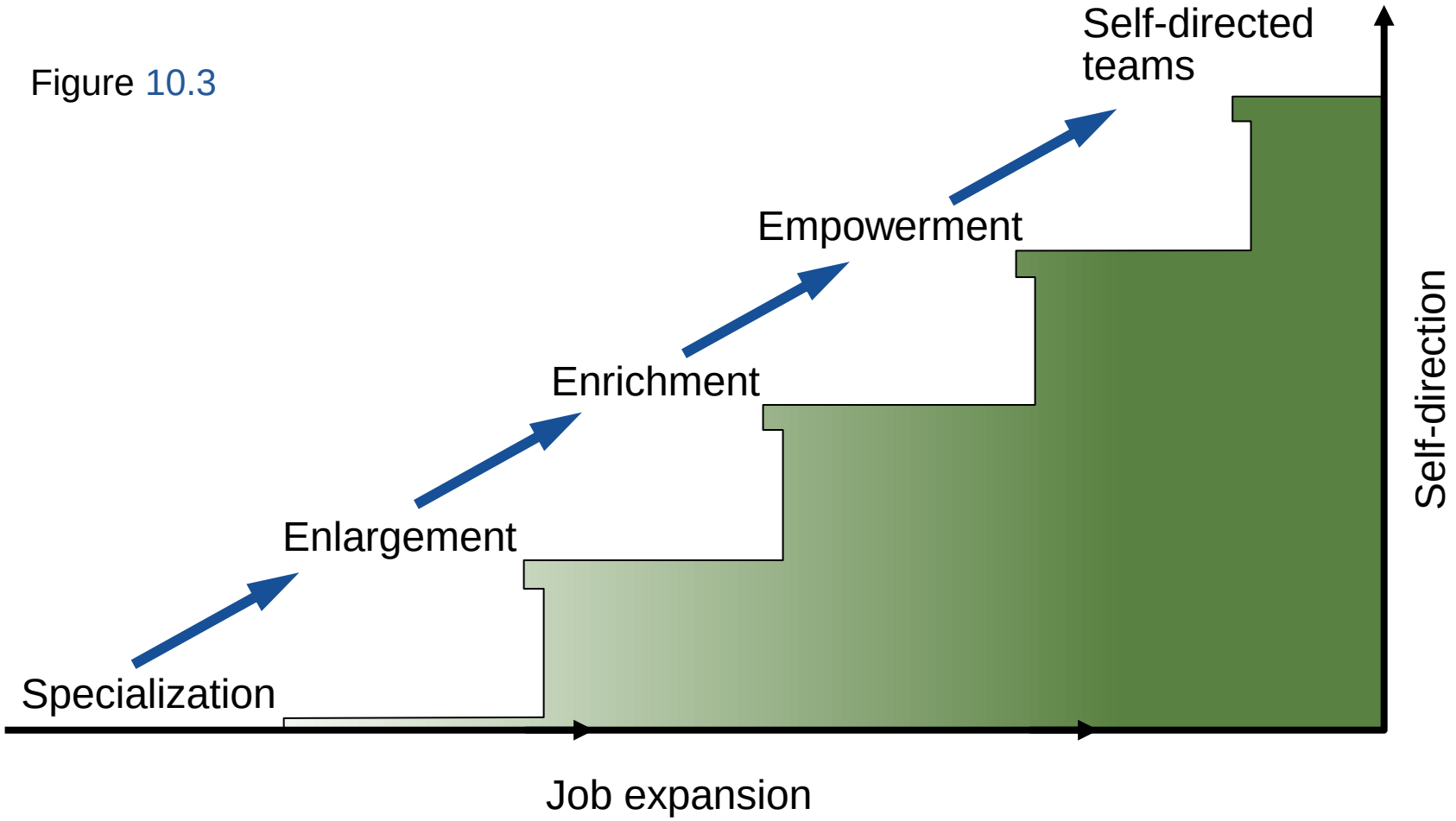
Self-Directed Teams

To maximize effectiveness, managers should

- Ensure those who have legitimate contributions are on the team
- Provide management support
- Ensure the necessary training
- Endorse clear objectives and goals
- Employ financial and non-financial rewards
- Reduce supervisory control

Job Design Continuum

Figure 10.3



Benefits of Teams and Expanded Job Designs

- Improved quality of work life
- Improved job satisfaction
- Increased motivation
- Allows employees to accept more responsibility
- Improved productivity and quality
- Reduced turnover and absenteeism

Limitations of Job Expansion

- *Higher capital cost*
- *Individual differences*
- *Higher wage rates*
- *Smaller labor pool*
- *Higher training costs*

Limitations of Job Expansion

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Motivation and Incentive Systems

- *Bonuses* – cash or stock options
- *Profit-sharing* – profits for distribution to employees
- *Gain sharing* – rewards for improvements
- *Incentive systems* – typically based on production rates
- *Knowledge-based* systems – reward for knowledge or skills

Ergonomics and the Work Environment

- **Ergonomics** is the study of the human interface with the environment and machines
  - Often called *human factors*
- Operator input to machines needs to be carefully evaluated

Ergonomics and Work Methods

- Feedback to operators
- The work environment
  - *Illumination*
  - *Noise*
  - *Temperature*
  - *Humidity*

Recommended Levels of Illumination

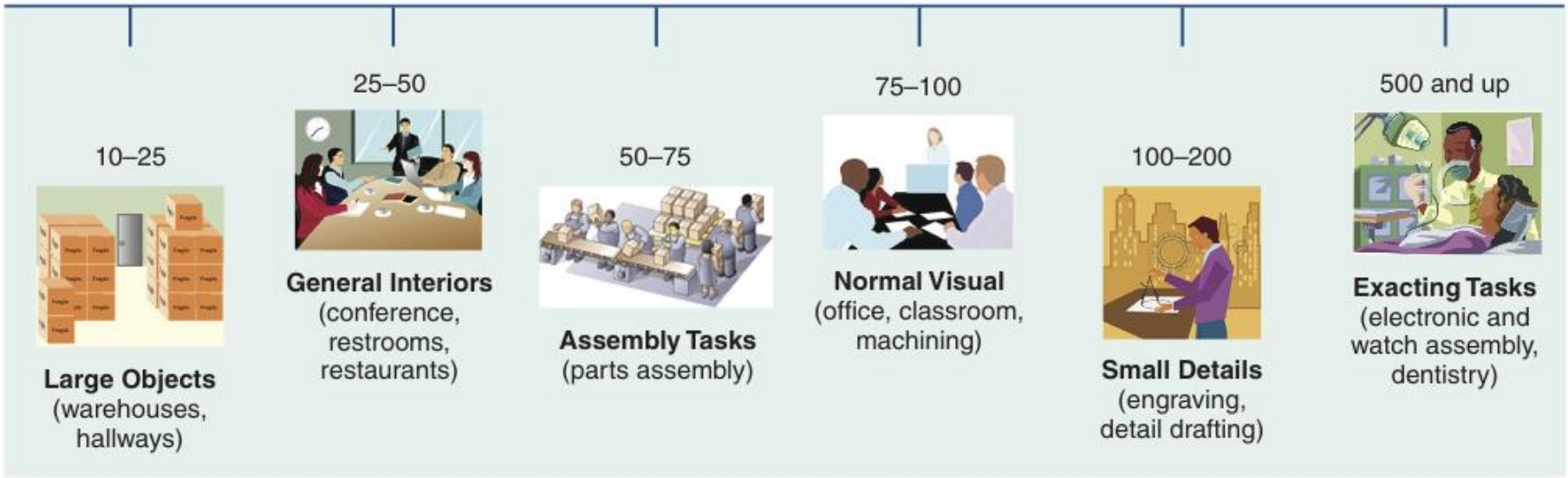


Figure 10.4a

Levels of Illumination

TASK CONDITION	TYPE OF TASK OR AREA	ILLUMINATION LEVEL	TYPE OF ILLUMINATION
Small detail, extreme accuracy	Sewing, inspecting dark materials	100	Overhead ceiling lights and desk lamp
Normal detail, prolonged periods	Reading, parts assembly, general office work	20-50	Overhead ceiling lights
Good contrast, fairly large objects	Recreational facilities	5-10	Overhead ceiling lights
Large objects	Restaurants, stairways, warehouses	2-5	Overhead ceiling lights

Decibel Levels

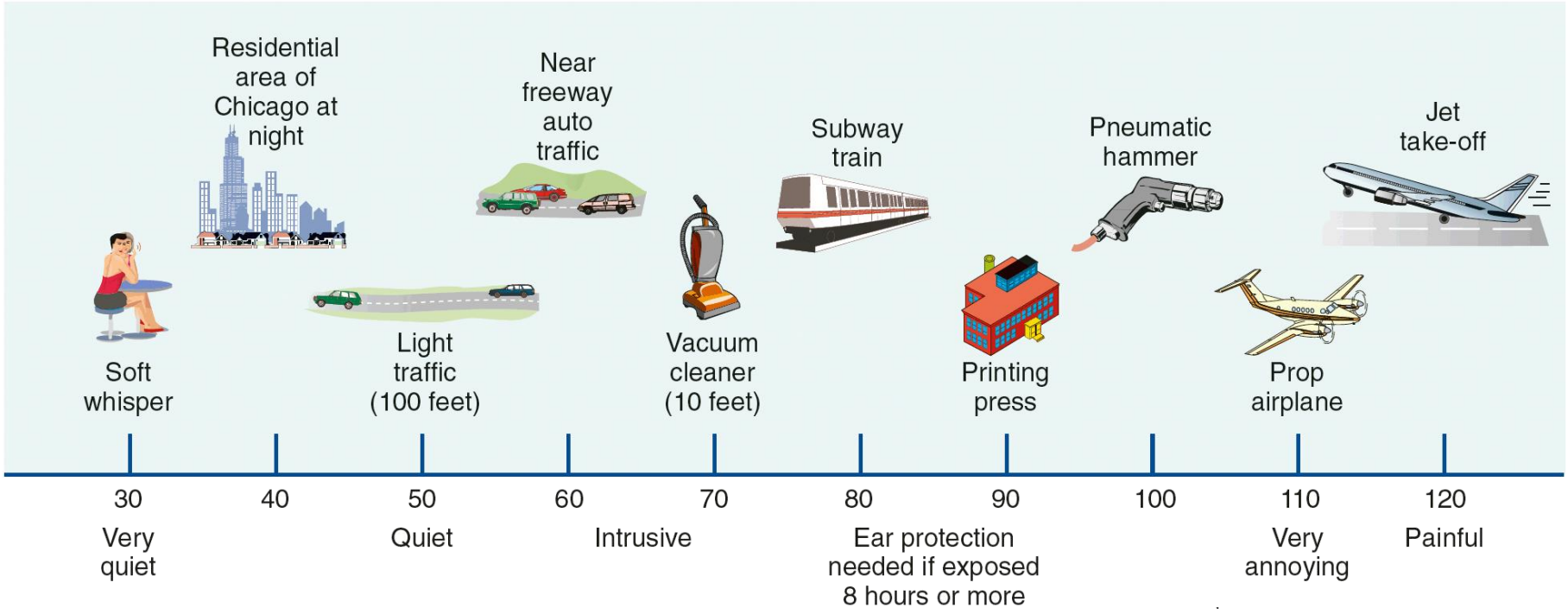


Table 10.4b

Methods Analysis

- Focuses on how task is performed
- Used to analyze
  1. Movement of individuals or material
     - *Flow diagrams* and *process charts*
  2. Activities of human and machine and crew activity
     - *Activity charts*
  3. Body movement
     - *Operations charts*

Flow Diagram

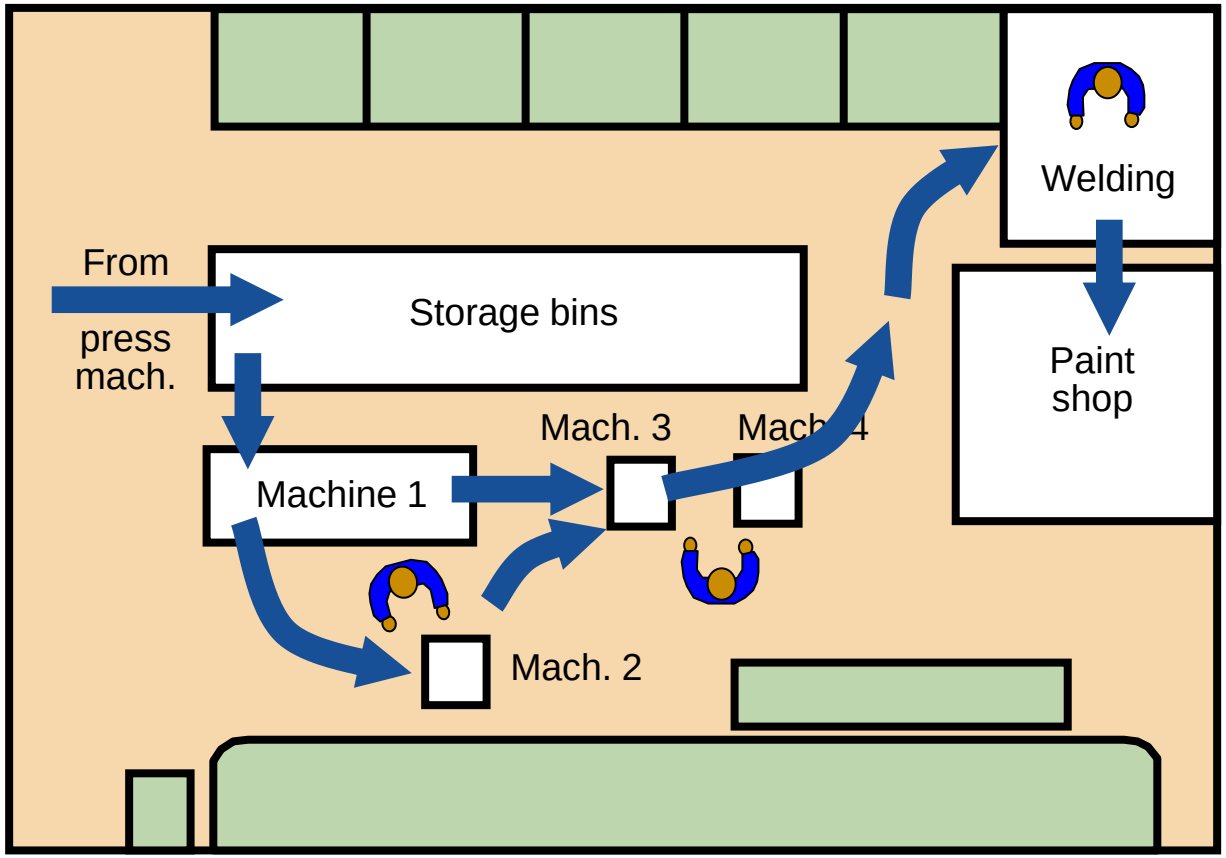


Figure 10.5 (a)

Flow Diagram

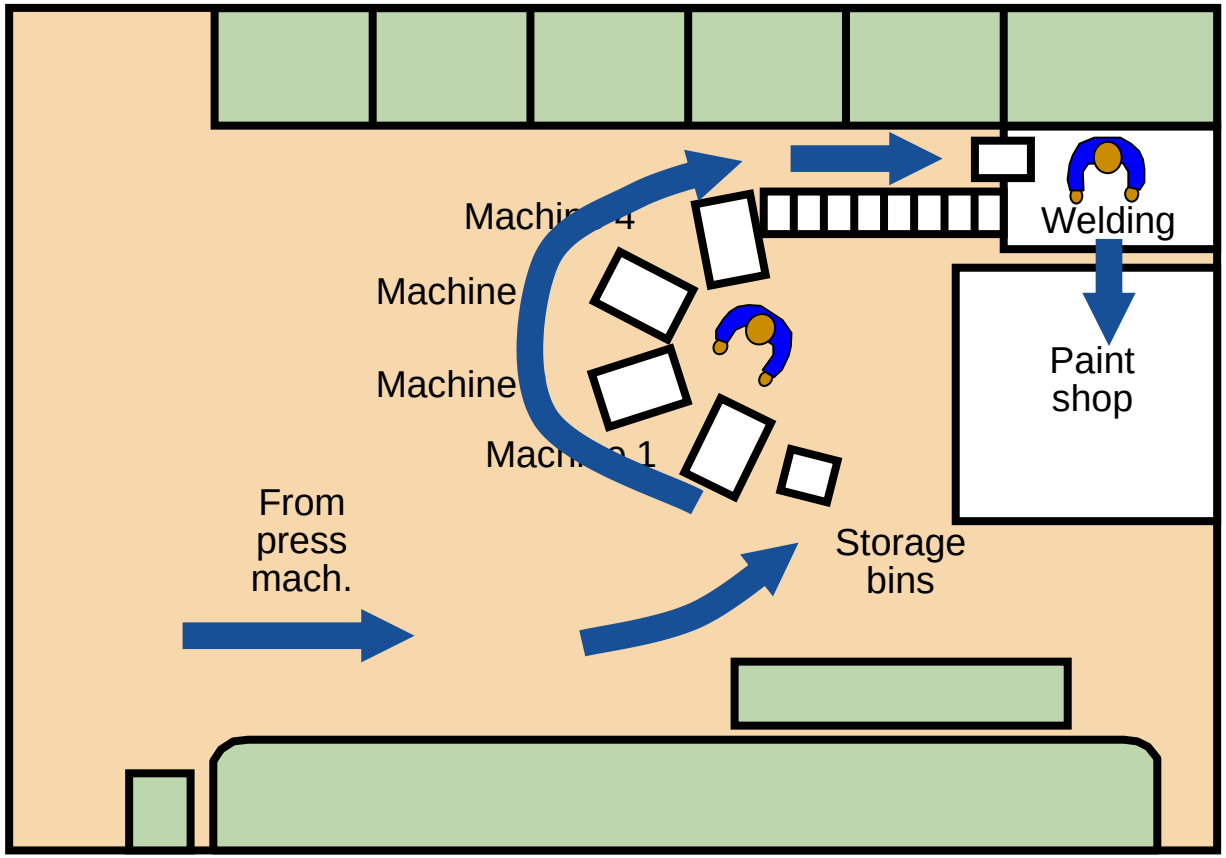


Figure 10.5 (b)

Process Chart

Present Method ☐ PROCESS CHART
Proposed Method ☒

SUBJECT CHARTED Axle-stand Production DATE 5/1/15
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; ⇨ = transport; □ = inspect; D = delay; ▽ = storage

Figure 10.5 (c)

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: BR

SUBJECT *Quick Car Lube* DATE *5-1-15*
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

Operations Chart

Figure 10.7

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

PROCESS: Scooping Ice for Coffee
EQUIPMENT: Scoop
OPERATOR: Starbucks
STUDY NO: _____ ANALYST: CM
DATE: 5 /1 /15 SHEET NO. 1 of 2
METHOD (PRESENT / PROPOSED)
REMARKS: Partial Study

LEFT-HAND ACTIVITY Present METHOD	DIST.	SYMBOLS	SYMBOLS	DIST.	RIGHT-HAND ACTIVITY Present METHOD
1 Reach for cup		●⇨□D▽	○⇨□D▽		Idle
2 Grasp cup		●⇨□D▽	○⇨□D▽		Idle
3 Move cup	6"	○➡□D▽	○⇨□D▽		Idle
4 Hold cup		○⇨□D▽	●⇨□D▽		Reach for scoop
5 Hold cup		○⇨□D▽	●⇨□D▽		Grasp scoop
6 Hold cup		○⇨□D▽	○➡□D▽	8"	Move scoop to ice
7 Hold cup		○⇨□D▽	●⇨□D▽		Scoop ice

The Visual Workplace

- Use low-cost visual devices to share information quickly and accurately
- Displays and graphs replace printouts and paperwork
- Able to provide timely information in a dynamic environment
- System should focus on improvement

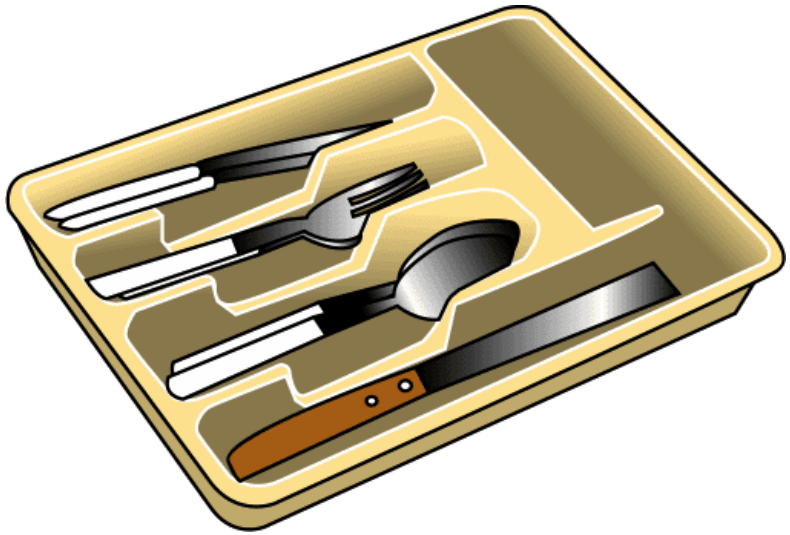
The Visual Workplace

Visual signals can take many forms and serve many functions

- Present the big picture
- Performance
- Housekeeping

The Visual Workplace

Visual utensil holder encourages housekeeping



A "3-minute service" clock reminds employees of the goal

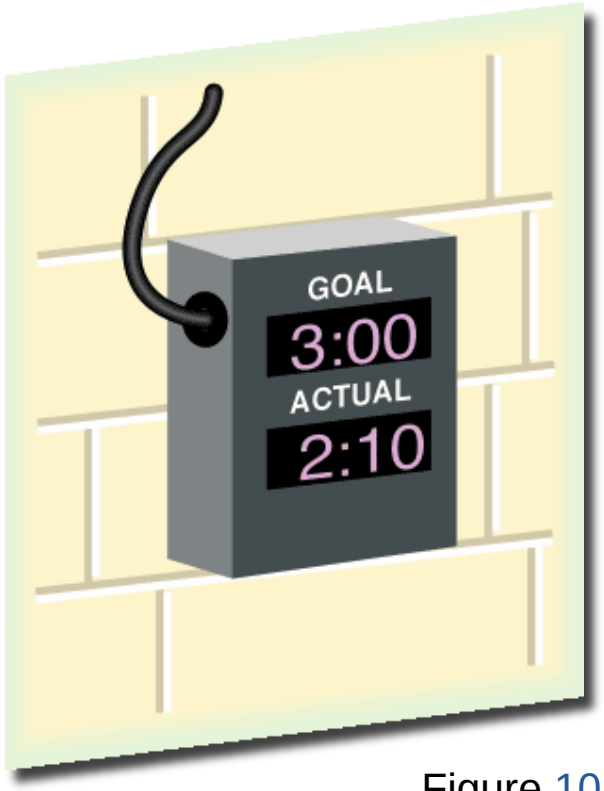
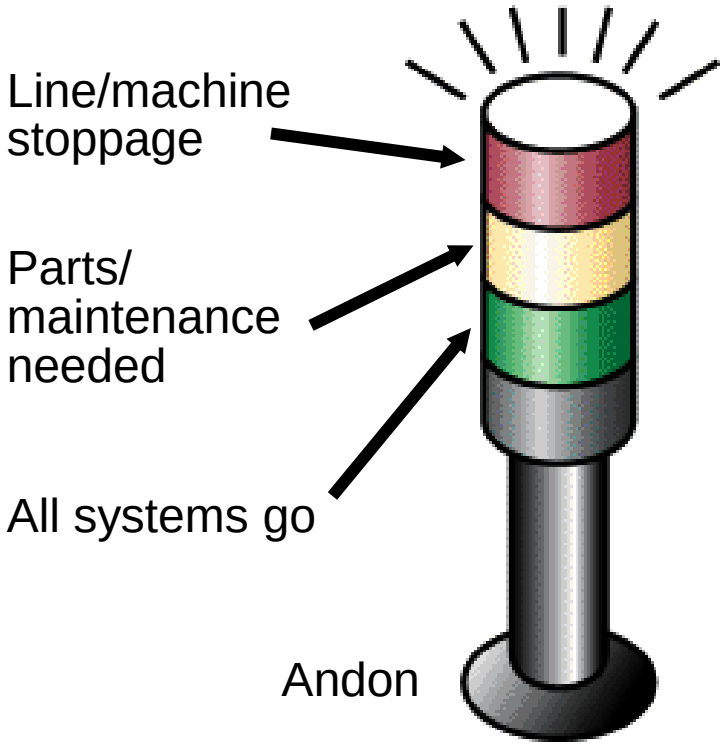


Figure 10.8

The Visual Workplace

Visual signals at the machine notify support personnel



Visual kanbans reduce inventory and foster JIT

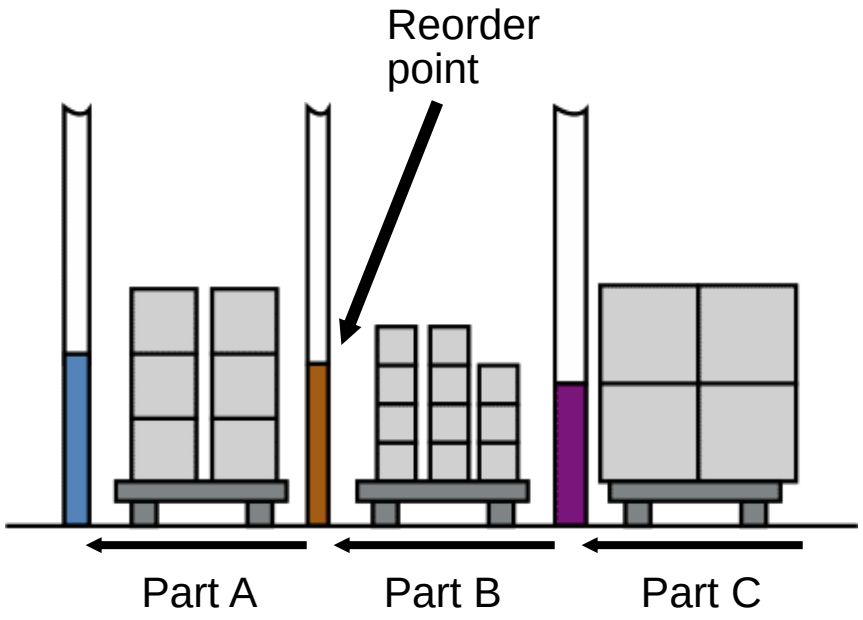
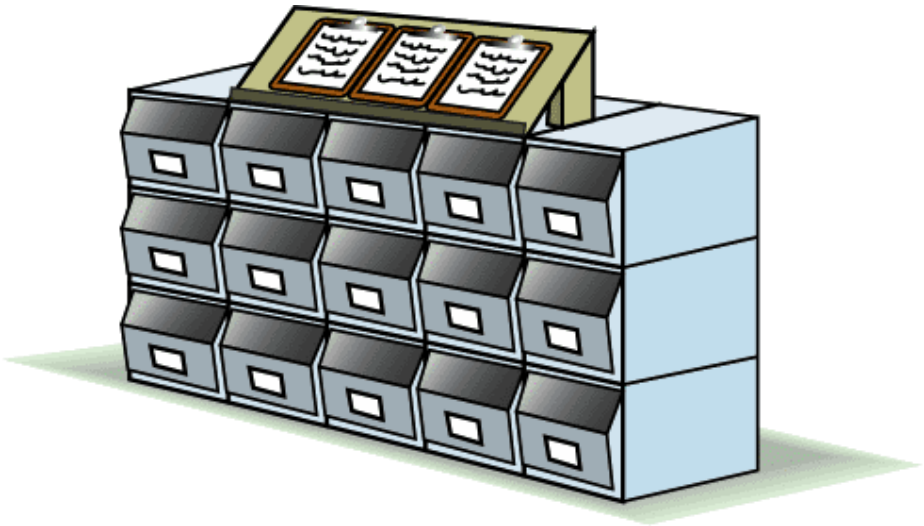
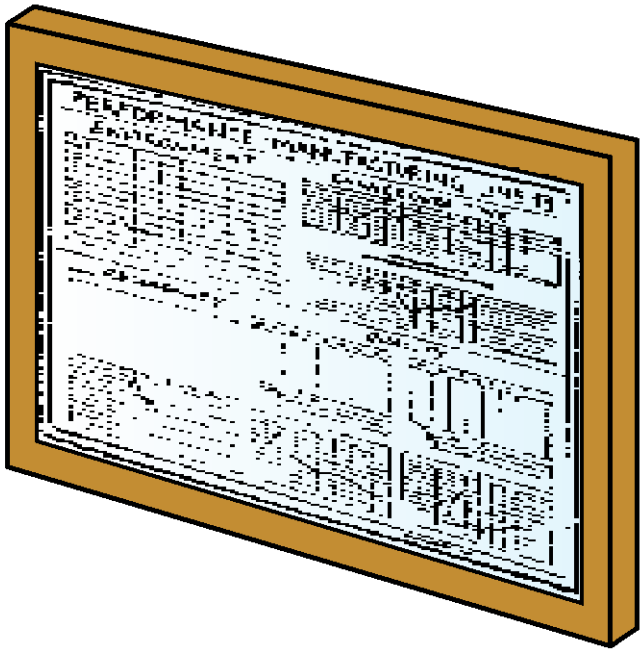


Figure 10.8

The Visual Workplace



Quantities in bins indicate ongoing daily requirements, and clipboards provide information on schedule changes



Company data, process specifications, and operating procedures are posted in each work area

Figure 10.8

Labor Standards

- Effective manpower planning is dependent on a knowledge of the labor required
- Labor standards are the amount of time required to perform a job or part of a job
- Accurate labor standards help determine labor requirements, costs, and fair work

Labor Standards

- Started early in the 20th century
- Important to both manufacturing and service organizations
- Necessary for determining staffing requirements
- Important to labor incentive systems

Meaningful Standards Help Determine

1. Labor content of items produced
2. Staffing needs
3. Cost and time estimates
4. Crew size and work balance
5. Expected production
6. Basis of wage-incentive plans
7. Efficiency of employees

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

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

Time Studies

1. Define the task to be studied
2. Divide the task into precise elements
3. Decide how many times to measure the task
4. Time and record element times and rating of performance

Time Studies

5. Compute **average observed time**

$$\text{Average observed time} = \frac{\text{Sum of the times recorded to perform each element}}{\text{Number of observations}}$$

6. Determine performance rating and **normal time**

$$\text{Normal time} = \text{Average observed time} \times \text{Performance rating factor}$$

Time Studies

7. Add 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 allowances*
  - 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

TABLE 10.1	**Allowance Factors (in percentage) for Various Classes of Work**
1. Constant allowances:	
(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

TABLE 10.1	**Allowance Factors (in percentage) for Various Classes of Work**
(C)	Use of force or muscular energy in lifting, pulling, pushing
	Weight lifted (pounds)
20	3
40	9
60	17

Rest Allowances

TABLE 10.1	**Allowance Factors (in percentage) for Various Classes of Work**	
(D)	Bad light:	
	(i) Well below recommended ……	2
	(ii) Quite inadequate ……	5
(E)	Noise level:	
	(i) Intermittent–loud ……..…….	2
	(ii) Intermittent–very loud or high pitched ..…….	5

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

$$\text{Standard time} = \frac{\text{Normal time}}{1 - \text{Allowance factor}} = \frac{3.4}{1 - .13} = \frac{3.4}{.87}$$

= 3.9 minutes

Time Study Example 2

Allowance factor = 15%

	OBSERVATIONS (MIN)					PERFORMANCE RATING
JOB ELEMENT	**1**	**2**	**3**	**4**	**5**	
(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 time* 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

$$\text{Standard time} = \frac{\text{Total normal time}}{1 - \text{Allowance factor}}$$

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

Determine Sample Size

1. How accurate we want to be
2. The desired level of confidence
3. How much variation exists within the job elements

Determine Sample Size

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

where

h	=	accuracy level (acceptable error) 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

Required sample si

where h = accuracy level (accep
job element expresse
z = number of standard d
level of confidence
s = standard deviation of
$\bar{x}$ = mean of the initial sar
n = required sample size

TABLE 10.2

Common *z*-Values

DESIRED CONFIDENCE (%)	*z*-VALUE (STANDARD DEVIATION REQUIRED FOR DESIRED LEVEL OF CONFIDENCE)
90.0	1.65
95.0	1.95
95.45	2.00
99.0	2.58
99.73	3.00

Time Study Example 3

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

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

$z = 1.96$ (from Table S10.2 or Appendix I)

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

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

Time Study Example 3

Variations

If desired accuracy h is expressed as an absolute amount, substitute e for $h\bar{x}$, where e is the absolute amount of acceptable error

$$n = \left(\frac{zs}{e}\right)^2$$

Time Study Example 3

Variations

When the standard deviation s is not provided, it must be computed

$$s = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n - 1}} = \sqrt{\frac{\sum (\text{Each sample observation} - \bar{x})^2}{\text{Number in sample} - 1}}$$

where x_i = value of each observation

$\bar{x}$ = mean of the observations

n = number of observations in the sample

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

MTM Table

Figure 10.9

GET and PLACE			DISTANCE RANGE IN IN.	<8	>8 <20	>20 <32
WEIGHT	CONDITIONS OF GET	PLACE ACCURACY	MTM CODE	1	2	3
<2 LB	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 LB <18 LB		APPROXIMATE	AH	25	45	55
		LOOSE	AJ	40	65	75
		TIGHT	AK	50	75	85
>18 LB <45 LB		APPROXIMATE	AL	90	106	115
		LOOSE	AM	95	120	130
		TIGHT	AN	120	145	160

MTM Example

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

TABLE 10.3 MTM-HC Analysis: Pouring Tube Specimen

ELEMENT DESCRIPTION	ELEMENT	TIME
Get tube from rack	AA2	35
Uncap, place on counter	AA2	35
Get centrifuge tube, place at sample table	AD2	45
Pour (3 seconds)	PT	83
Place tubes in rack (simo)	PC2	40
		Total TMU 238
.0006 x 238 = Total standard minutes = .14 or about 8.6 seconds		

Work Sampling

- Estimates percent of time a worker spends on various tasks
- Requires random observations to record worker activity
- Determines how employees allocate their time
- Can be used to set staffing levels, reassign duties, estimate costs, and set delay allowances

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

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

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 (as a decimal)

Work Sampling Example

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

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

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 Example

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

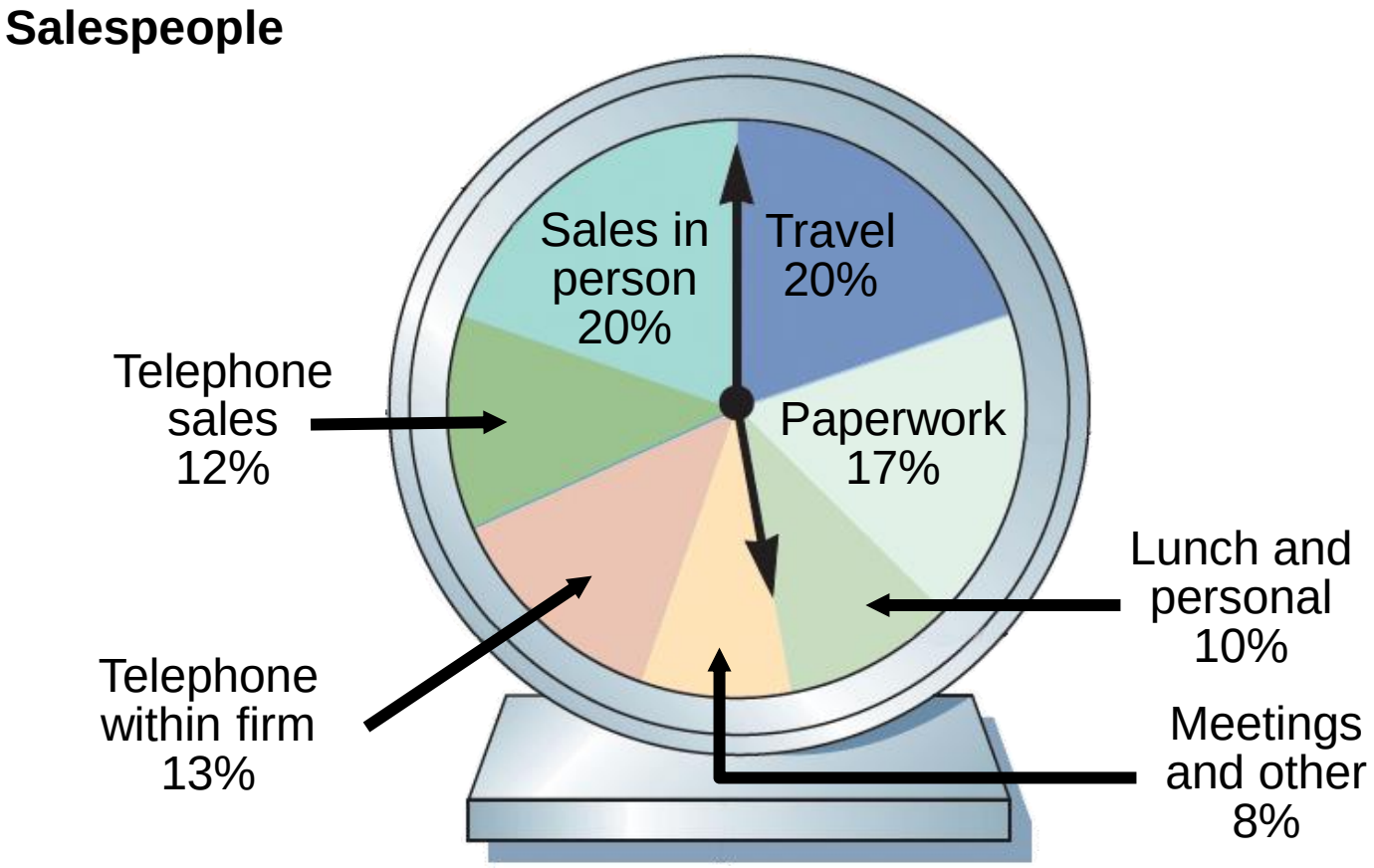


Figure 10.10

Work Sampling Time Studies

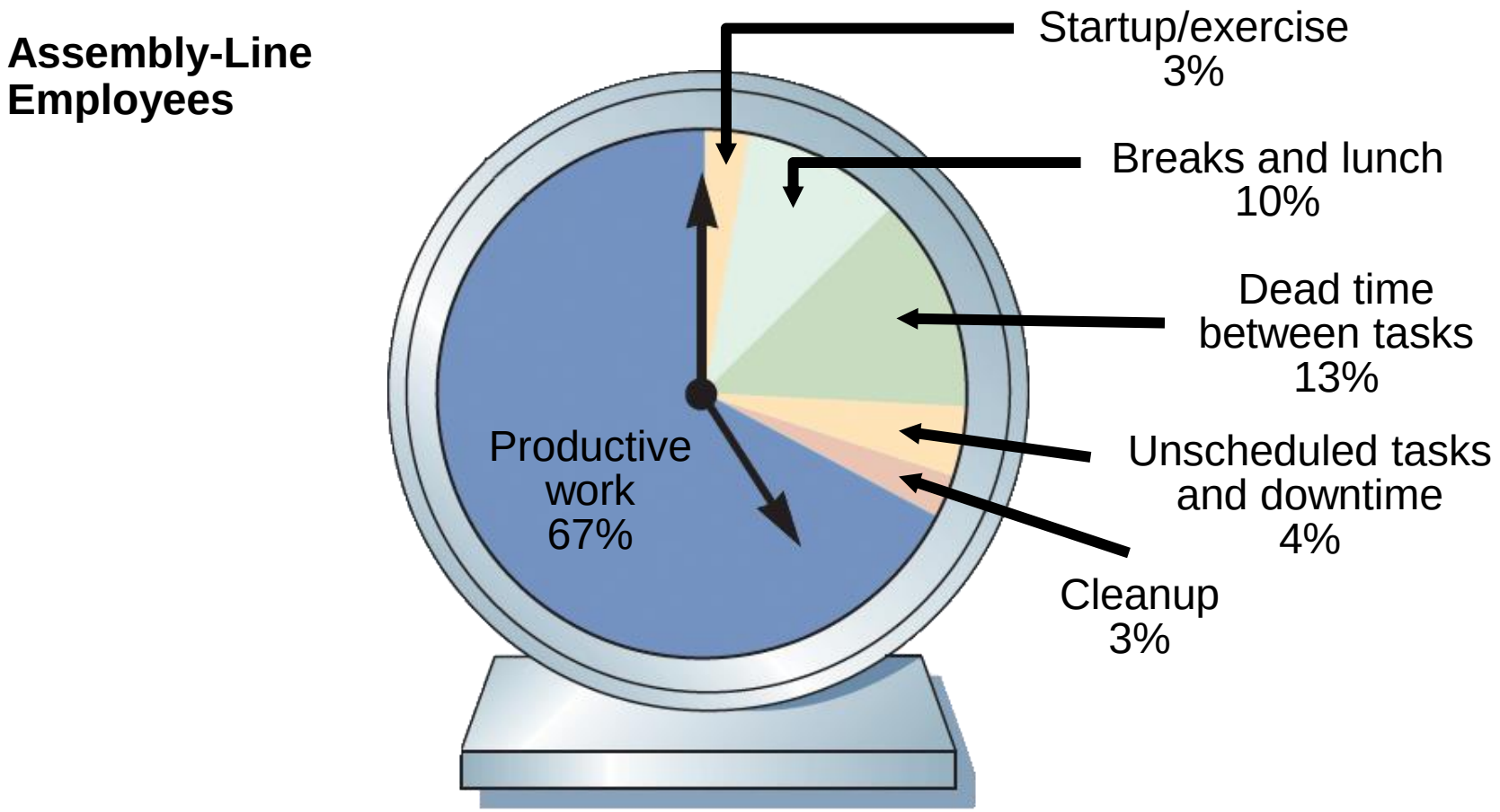


Figure 10.10

Work Sampling

- Advantages of work sampling
  - 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

- Disadvantages of work sampling
  - Does not divide work elements as completely as time study
  - Can yield biased results if observer does not follow random pattern
  - Less accurate, especially when job element times are short

Ethics

- Fairness, equity, and ethics are important constraints of job design
- Important issues may relate to equal opportunity, equal pay for equal work, and safe working conditions
- Helpful to work with government agencies, trade unions, insurers, and employees