



Motion Study and Work Design

Sections:

1. Basic Motion Elements and Work Analysis
2. Micromotion Analysis
3. Principles of Motion Economy and Work Design



Definitions

- Motion study - analysis of the basic hand, arm, and body movements of workers as they perform work
- Work design - design of the methods and motions used to perform a task
- Includes:
 - Workplace layout and environment
 - Tooling and equipment used in the task



Basic Motion Elements

- Therbligs – 17 basic motion elements
 - Basic building blocks of virtually all manual work performed at a single location
 - With modification, used today in several work measurement systems, e.g., MTM and MOST
 - Some of the motion element names and definitions have been revised

<http://gilbrethnetwork.tripod.com/therbligs.html>



17 Therbligs

1. Transport empty (TE) – reach for an object
2. Grasp (G) – grasp an object
3. Transport loaded (TL) – move an object with hand and arm
4. Hold (H) – hold an object
5. Release load (RL) – release control of an object
6. Use (U) – manipulate a tool



17 Therbligs (continued)

7. Pre-position (PP) – position object for next operation
8. Position (P) – position object in defined location
9. Assemble (A) – join two parts
10. Disassemble (DA) – separate multiple parts that were previously joined
11. Search (Sh) – attempt to find an object using eyes or hand



17 Therbligs (continued)

12. Select (St) – choose among several objects in a group
13. Plan (Pn) – decide on an action
14. Inspect (I) – determine quality of object
15. Unavoidable delay (UD) – waiting due to factors beyond worker control
16. Avoidable delay (AD) – worker waiting
17. Rest (R) – resting to overcome fatigue



Classification of Therbligs

Effective therbligs:

- Transport empty
- Grasp
- Transport loaded
- Release load
- Use
- Assemble
- Disassemble
- Inspect
- Rest

Ineffective therbligs:

- Hold
- Pre-position
- Position
- Search
- Select
- Plan
- Unavoidable delay
- Avoidable delay



Benefits of Classification

- Use motions which are easy and effective,
- Discard motions which are awkward, fatiguing and ineffective.
- People who accomplish the most do not necessarily work hardest.
- Speed up or Stretch out vs. More quality work done & Less energy expenditure



Micromotion Analysis

- Activities of two or more workers on group work
- Relationship of operator's activities and machine
- Timing operation
- Obtain time-motion data for time standards
- Permanent record of method and time
- Research (motion and time study)



Micromotion Analysis

- Finding the preferred method of doing work
- Training individuals to understand the meaning of motion study



Micromotion Analysis

- Analysis of therbligs that make up a repetitive task
- Objectives:
 - Eliminate ineffective therbligs if possible
 - Avoid holding objects with hand – Use workholder
 - Combine therbligs – Perform right-hand and left-hand motions simultaneously
 - Simplify overall method
 - Reduce time for a motion, e.g., shorten distance



Micromotion Analysis – Technique

1. Filming operation
2. Analyzing the film
3. Charting the results
4. Developing an improved method



Principles of Motion Economy

- Developed over many years of practical experience in work design
- Guidelines to help determine
 - Work method
 - Workplace layout
 - Tools, and equipment
- Objective: to maximize efficiency and minimize worker fatigue



Three Categories of Principles

1. Principles that apply to the use of the human body
2. Principles that apply to the workplace arrangement
3. Principles that apply to the design of tooling and equipment



Use of Human Body

1. Design work to fully utilize both hands
2. The two hands should begin and end their motions at the same time
3. Hand and arm motions should be symmetrical and simultaneous
4. Design work to favor preferred hand
5. Worker's two hands should not be idle at the same time



Use of Human Body

6. Method should consist of smooth continuous curved motions rather than straight motions with abrupt changes in direction
7. Use momentum to facilitate task
8. Take advantage of gravity – Don't oppose it
9. Method should achieve a natural rhythm of the motions involved
10. Minimize eye focus and travel



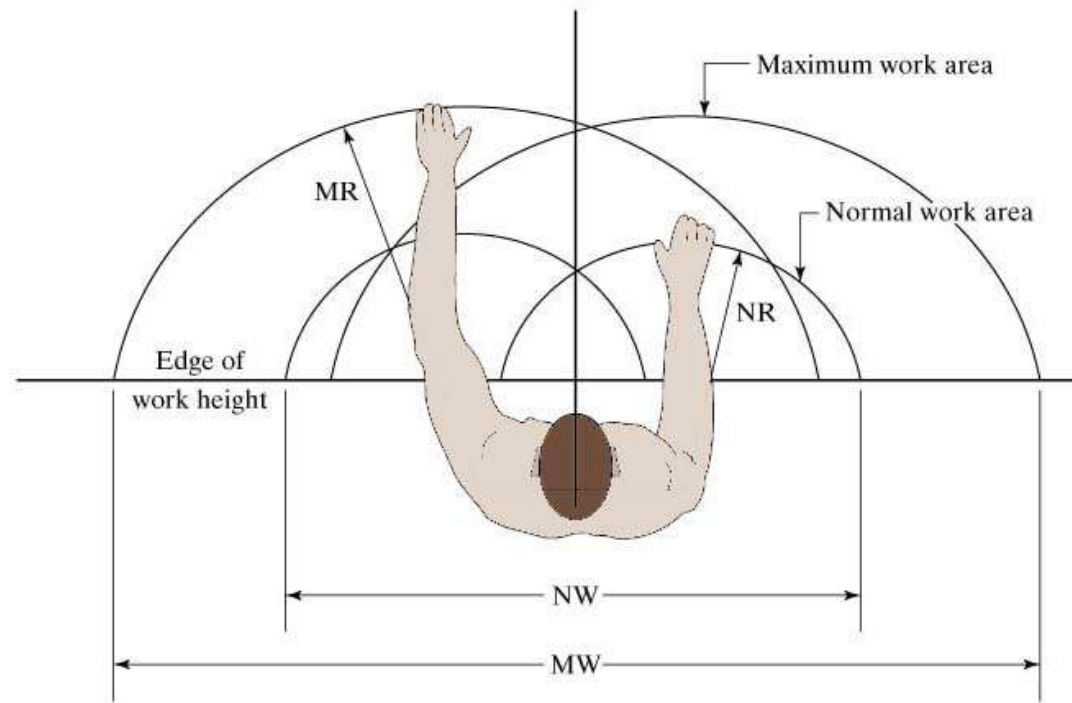
Use of Human Body

11. Use lowest classification of hand and arm motion (five classifications)
 - 1) Finger
 - 2) Finger and wrist
 - 3) Finger, wrist, and forearm
 - 4) Finger, wrist, forearm, and upper arm
 - 5) Finger, wrist, forearm, upper arm, and shoulder
12. Design method to utilize feet and legs where appropriate



Workplace Arrangement

- Normal and maximum working areas in the workplace (key and dimensions given in text)





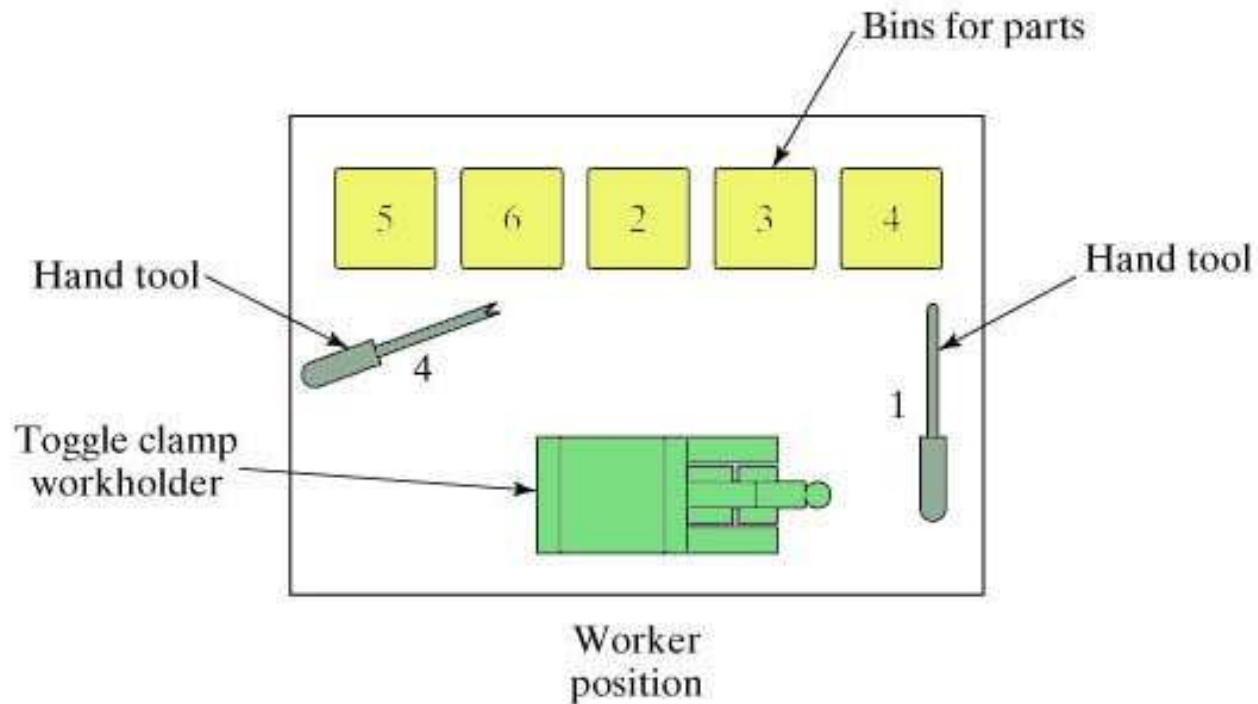
Workplace Arrangement

1. Locate tools and materials in fixed positions within the work area
2. Locate tools and materials close to where they are used
3. Locate tools and materials to be consistent with sequence of work elements



Illustration of First Three Principles

Poor arrangement of parts and tools in workplace

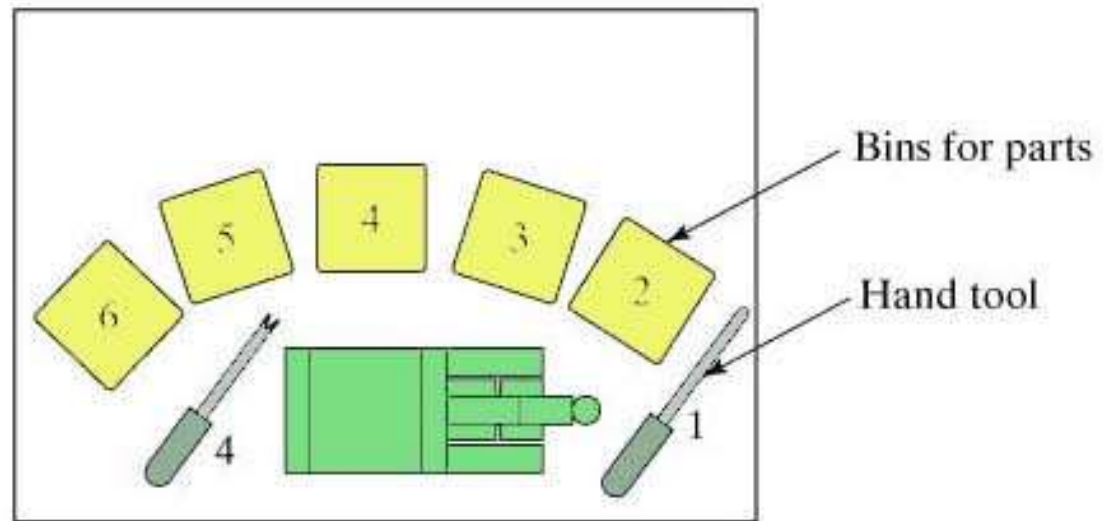


(a)



Illustration of First Three Principles

Good arrangement of parts and tools in workplace



Worker
position

(b)



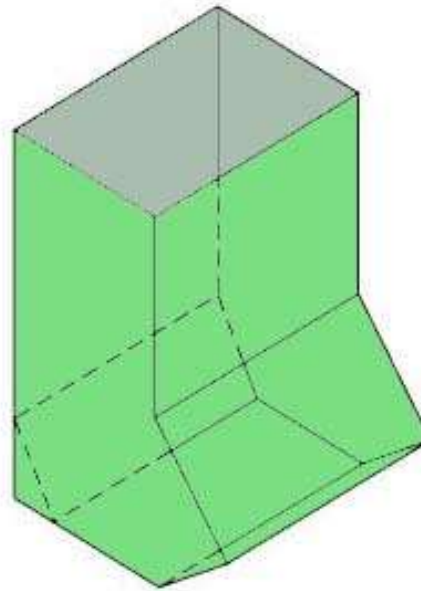
Workplace Arrangement

4. Use gravity feed bins to deliver small parts and fasteners

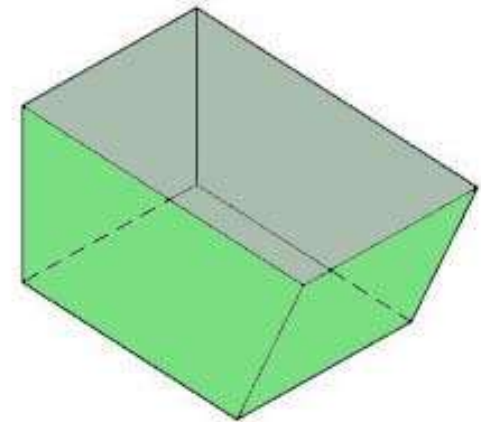
Two types of bins used for small parts and fasteners in the workplace:

(a) gravity feed bin

(b) conventional rectangular bin



(a)



(b)

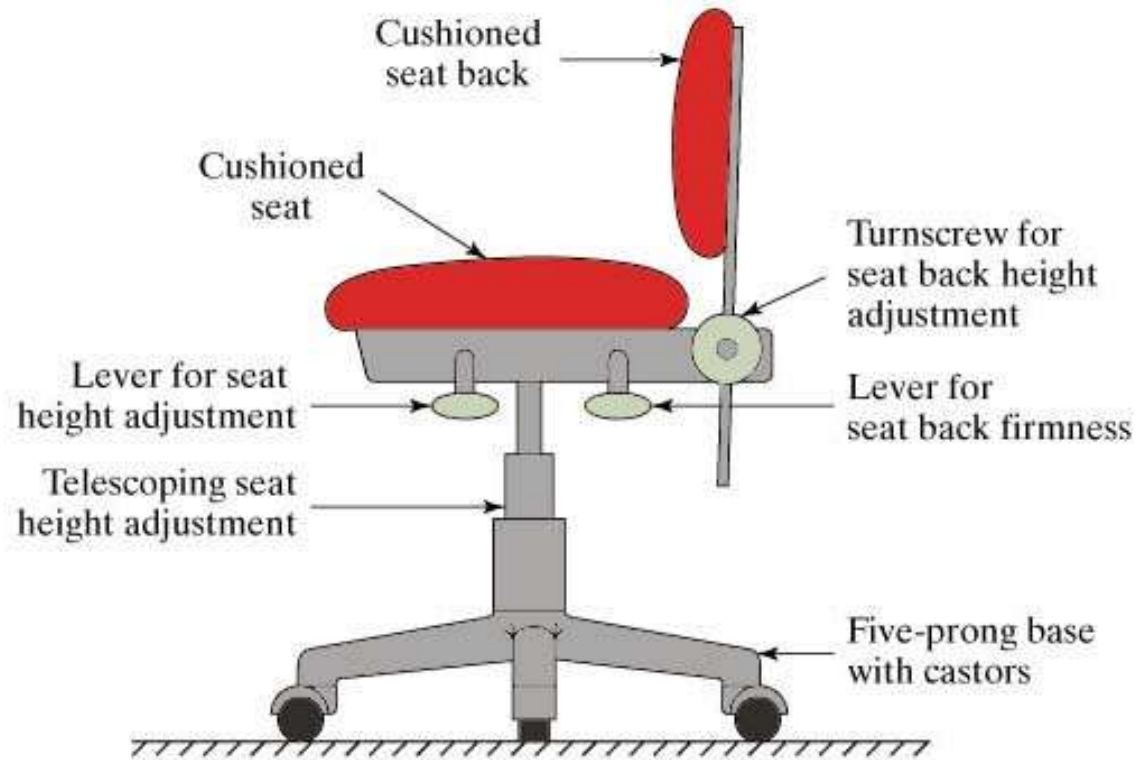


Workplace Arrangement

5. Use gravity drop chutes for completed work units where appropriate
6. Provide adequate illumination
7. A proper chair should be provided for the worker
 - Adjustable to the size of the worker
 - Seat height and back adjustments
 - Padded seat and back



Adjustable Chair for Workplace





Design of Tooling and Equipment

1. Workholding devices should be designed for the task
2. Hands should be relieved of work elements that can be performed by the feet using foot pedals
3. Combine multiple functions into one tool where possible
4. Perform multiple operations simultaneously rather than sequentially



Design of Tooling and Equipment

5. Where feasible, perform operation on multiple parts simultaneously
6. Design equipment controls for operator convenience and error avoidance
7. Hand tools and portable power tools should be designed for operator comfort and convenience
8. Mechanize or automate manual operations if economically and technically feasible