HUMAN FACTORS IN ENGINEERING

UNIT-3

UNIT 3 - SYLLABUS

MACHINE CONTROLS:

Improvement of human work place through controls, Displays and Controls, Shapes and sizes of various controls and displays, Multiple display and control situations, Design of major controls in automobiles and machine tools, Principles of hand tool design.

WORK PLACE AND SEATING DESIGN:

Design of office furniture, Redesign of instruments, Work process: Duration of rest periods, Design of visual displays, Design for shift work.

MACHINE CONTROLS

- Most machines **require human control**, they must include control devices such as wheels, pushbuttons, or levers.
- It is through these control devices that people make their presence known to machines-that is, in addition to kicking the side of a candy machine.

MACHINE CONTROLS

- Computers are becoming part and parcel of our everyday lives, both on and off the job.
- Fortunately, **computers cannot yet read our minds**. In order to "communicate" with computers we have to use **various devices** to input commands and data.

MACHINE CONTROLS

- Machine controls are the components that allow operators to control the operation of machinery, equipment, and automated systems.
- Effective machine controls are critical for ensuring safe and efficient operation of machinery and minimizing the risk of accidents and injuries.
- Most modern day machines uses combination of manual controls, computerized controls, displays, and safety controls to run them

MACHINE CONTROLS

FUNCTIONS OF CONTROLS:

The primary function of a control is to transmit control information to some device, mechanism, or system.

The type of information so transmitted can be divided into two broad classes: **discrete and continuous information**.

MACHINE CONTROLS

Discrete information is information that can represent only one of a limited number of conditions such as on-off; high-medium-Iow; boiler 1, boiler 2, boiler 3; or alphanumeric such as A, B, and C or 1, 2, and 3.

MACHINE CONTROLS

Continuous information, on the other hand, can assume any value on a continuum, such as speed (as 0 to 60 km/h), pressure [as 1 to 100 Ib/in^2 (0.07 to 7.03 kg/cm^2)], position of a valve (as fully closed to fully open), or amount of electric current (as 0 to 10 A).

MACHINE CONTROLS

GENERIC TYPES OF CONTROL:

There are numerous types of control devices available today. Certain types of controls are best suited for certain applications.

One simple way to classify controls is based on the type of **information they can most effectively transmit** (discrete versus continuous) and the force normally required to manipulate them (large versus small).

MACHINE CONTROLS

The amount of force required to manipulate a control is a function of the **device being controlled**, the mechanism of control, and the design of the control itself.

Electric and hydraulic systems typically require small forces to actuate controls, whereas direct mechanical linkage systems may require large forces.

Machine controls

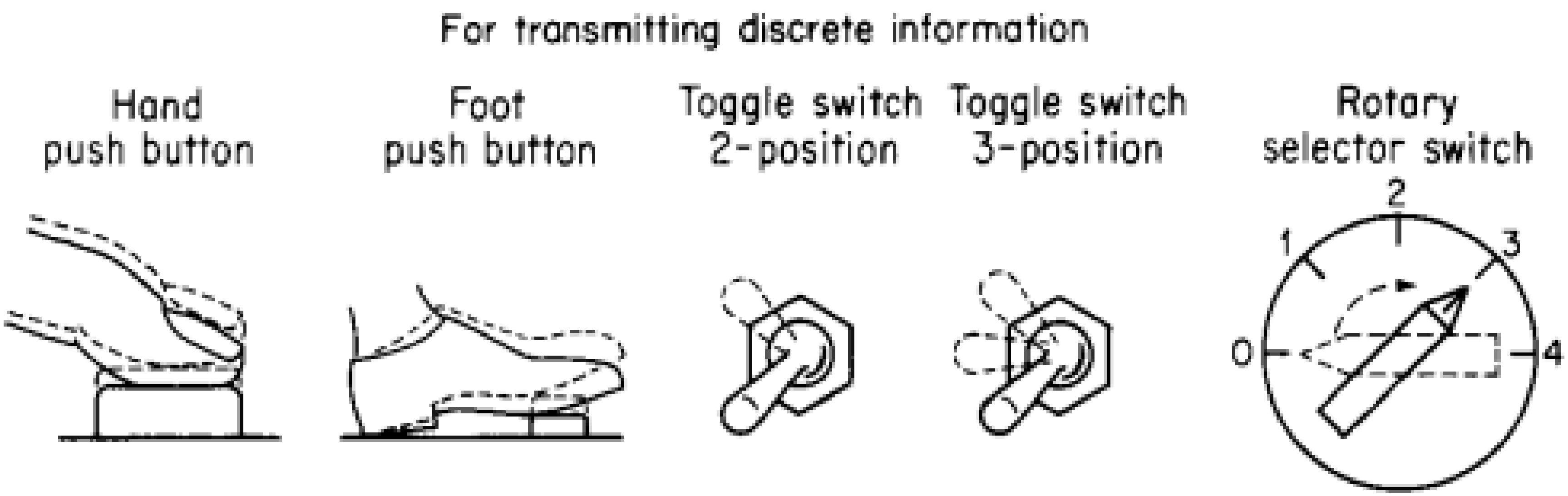
Control categories	Types within each category
Alphanumeric keyboards	Alternative alphabets
Balls	Track balls and computer mice as simply inverted
Cranks	Hand with and without offset handle, use for high-speed turning up to 200 rpm, max. rate decreases with the diameter
Joy sticks	Both discrete and continuous versions available, push-pull is usually more accurate than left-right or up-down
Knobs	Slide or rotary
Levers	All three classes but one-dimensional, hand operated
Plates	Pressure, force
Pedals	Rocker or linear movement, knee angle is critical for seated operator, maximum forces at about 160 degrees, close to standing operator.
Pushbuttons	Fixed position, automatic position return but one-dimensional operation.
Rudders	Both hand and foot operated
Switches	Light-actuated, push-pull, rotary, rocker, sound-actuated, toggle
Treadles	Usually foot-operated but can be hand-operated, usually center hinged
Wheels	Hand, indent, steering

MACHINE CONTROLS

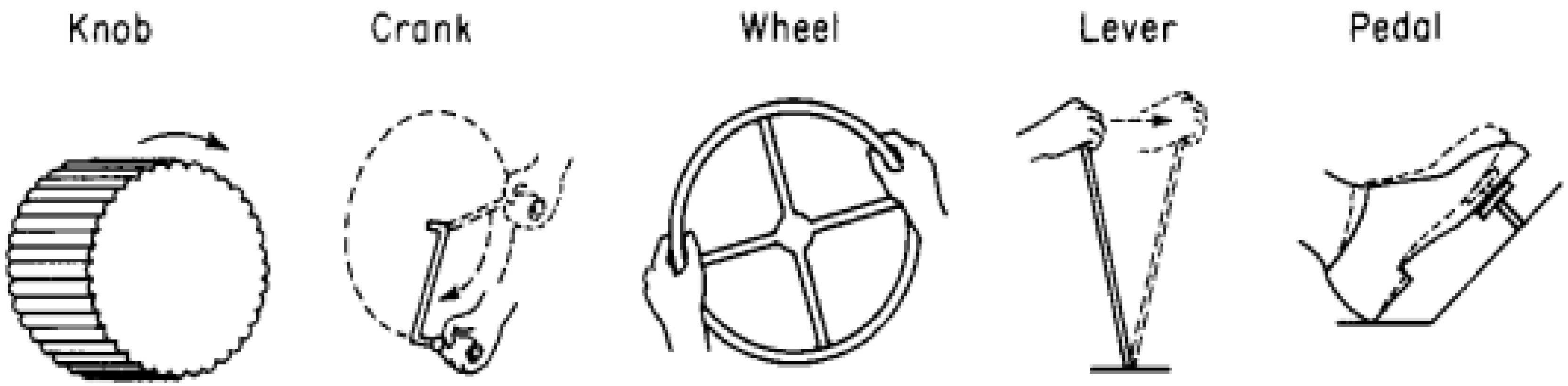
COMMON TYPES OF CONTROLS CLASSIFIED BY TYPE OF INFORMATION TRANSMITTED AND FORCE REQUIRED TO MANIPULATE

Force required to manipulate control	Type of information transmitted		
		Continuous	
	Discrete	Traditional	Cursor positioning
Small	Push buttons (including keyboards) Toggle switches Rotary selector switches Detent thumb wheels	Rotary knobs Multirotational knobs Thumb wheels Levers (or joysticks) Small cranks	Joysticks Trackballs Mice Digitizing tablets Touch tablets Light pens Touch screens
Large	Detent levers Large hand push buttons Foot push buttons	Handwheels Foot pedals Large levers Large cranks	

Examples of some types of control devices classified by the type of information they best transmit and the force required to activate them.

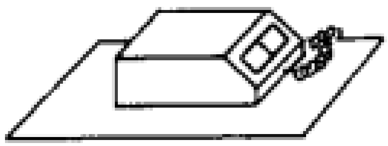


For transmitting traditional continuous information

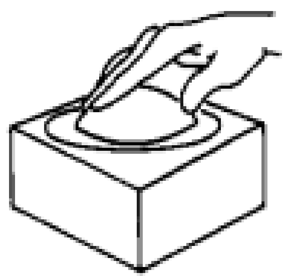


For transmitting cursor positioning information

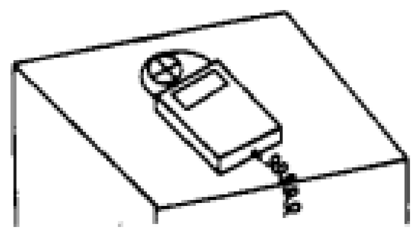
Mouse



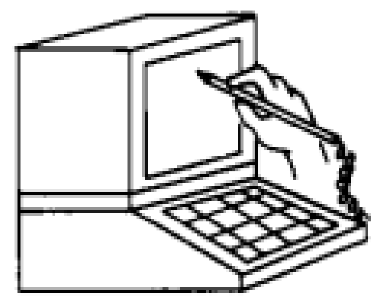
Trackball



Digitizing tablet



Light pen



Selection of an appropriate control device

Type of control	Speed	Accuracy	Force	Range of movement	Loads
Cranks, small	1	3	4	1	Up to 40 in-lb
Cranks, large	3	4	1	1	Over 40 in-lbs
Handwheels	3	4	2–3	2	Up to 150 in-lbs
Knobs	4	2	1	2	Up to 13 in-lbs
Lever-horizontal	1	3	3	3	Up to 30 lbs.
Lever-to-from body Vertical	1	2	Short 3 Long 1	3	
Lever- across body Vertical	2	2	2	4	1 hand < 20 lbs 2 hands < 30 lbs
Joystick	1	2	3	3	Up to 5 lbs.
Pedals	1	3	1	4	30 to 200 lbs.
Push-buttons	1	4	4	4	Up to 2 lbs.
Rotary selector switches	1	1	4	4	Up to 10 in-lbs.
Joystick selector Switches	1	1	3	4	Up to 30 lbs.

1 is most suitable , 4 is least suitable

PRINCIPLES IN DESIGN OF CONTROLS

- **Principles of controls pertaining to member movements:**

1. When a control requires the use of muscle bundles that are antagonistic to each other, the control actions are more accurate, but usually slower

Example: steering wheel of an automobile

2. The control should fit the body member that actuates it and the actuations should be performed in a natural movement of that member

- **Principles of controls pertaining to feedback:**

3.Controls should provide feedback to the activating person showing which control was touched and activated, when the activation occurred, and what control command was activated

- **Principles of controls pertaining to effort:**

4.Controls should not require continued effort to be held in a null position or in the position of the last setting

- **Principles of controls pertaining to arrangement :**

5.If controls are usually activated in a definite sequence, arrange them to follow that sequence

6.Arrange the controls to fit the operator’s mental model of the process being controlled

Example: startup controls, process-operation controls & shutdown controls

7.Arrange controls consistently from panel to panel, using identical or similar controls when the action is the same. When the action is different but the function is similar, arrange the same but use a different control as seen by the operator

It is important to tell the operator when things are the same, and when they are not the same but are similar

8. Keep control arrangements confined but not crowded

- **PRINCLES OF CONTROLS PERTAINING TO TYPE AND ORIENTATION**

9.Controls should have labels that identify each switch action briefly but unambiguously (no abbreviations), and which show automatic control changes.

10. Select and orient controls to avoid accidental activations.

Principles of controls pertaining to control layout :

11. Operators should be able to actuate controls from any reasonable posture during the task without loss of stability

- **Principles of controls pertaining to work methods :**

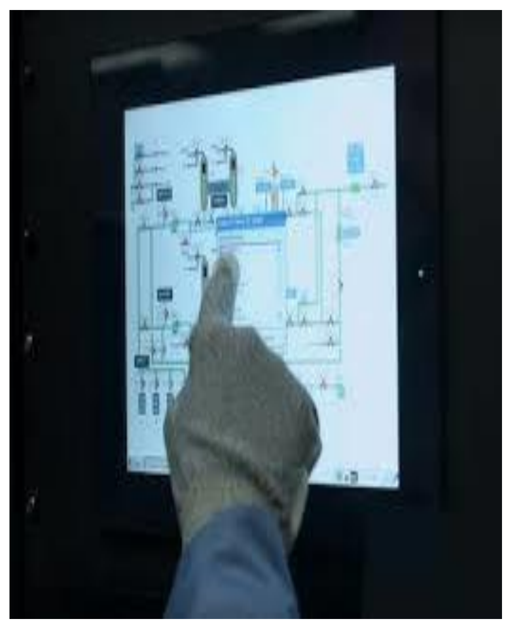
12.When one needs quick, fine-control adjustments, select those controls that employ body members of minimum mass.

13.Single controls that move in two and three dimensions are better than two or three single dimension controllers in terms of both speed and accuracy.

14.Terminate control actions with a mechanical stop. Use auditory feedback to indicate a change in control activation state.

DISPLAYS

- Displays are devices designed to communicate messages to people.
- In most cases, displays perform a supportive role, in which they supplement other sources of information that might be available to the person using the particular device



TYPES OF DISPLAYS

- Visual displays can be classified in several different ways

1. *Static* displays, such as signs, labels, or books always present the same information
2. *Dynamic* displays, on the other hand, such as speedometers, fuel gauges, oil pressure or temperature indicators on automobiles display values that change in response to conditions

Dynamic displays
- Analogue displays
- Digital displays

Static Displays

A dynamic display

Analog DC voltmeter

Analogue Speedometer

Auditory Displays: Sirens, Bells , Horns Etc

Spatial Displays

Old Compass

Digital Speedometer

Modern display on CNC machine

Displays on future cars

Virtual Displays

Virtual Screens

PRINCIPLES IN DESIGN OF DISPLAYS

- **Principles of Displays pertaining to Sensory Modality**

1.The most appropriate sensory modality of a display depends on its intended function, sensory demands of the background task, and sensory capabilities of its intended audience.

- Sensory modalities refer to the different ways in which we sense and perceive the world around us through our senses
- **Vision**- Status displays, warning lights, signs, or labels
- **Hearing**- tactile buzzers, Beep sounds
- **Touch-** vibrating phone
- **Taste**
- **Smell**
- **proprioception** (the sense of body position and movement)
- **vestibular sensation** (the sense of balance and spatial orientation)

2. Displays that combine sensory modalities can be particularly effective when tasks are performed under changing conditions.

- *Example :* If an auditory alarm goes off when some display reaches a critical value, it therefore becomes more likely that people will react quickly before the problem becomes serious

Beep response During abnormal conditions

Cont

- ***Principles on Display Location & Layout***

3. ***Locate visual displays where they can be seen and put more important visual displays in more central locations.***

- A common guideline is that displays should be located within 30 degrees of the operator’s typical line of sight. Clearly, displays that are not seen are not read.

Cont

4. Displays should provide their information at the time it needs to be used.

- Providing information at the time it is relevant reduces the need for people to remember it, and consequently can help eliminate errors due to forgetting, and is especially important if the display is providing warning or alerting information

5. ***Displays and display elements should be grouped consistently with the sequences in which they are used by the operators***

- Operators must move their eyes from display to display in certain tasks.
- The amount of eye movement required can be reduced by placing displays that are normally viewed in sequence closer together

Cont

6. Tasks requiring information integration are better served by more integral object- like displays

- Color coding is one commonly used strategy to help group related items in a display

7. *Objects that are placed close together will be more likely to be viewed as being related.*

Thus, two adjacent displays may be assumed to be in some sense related

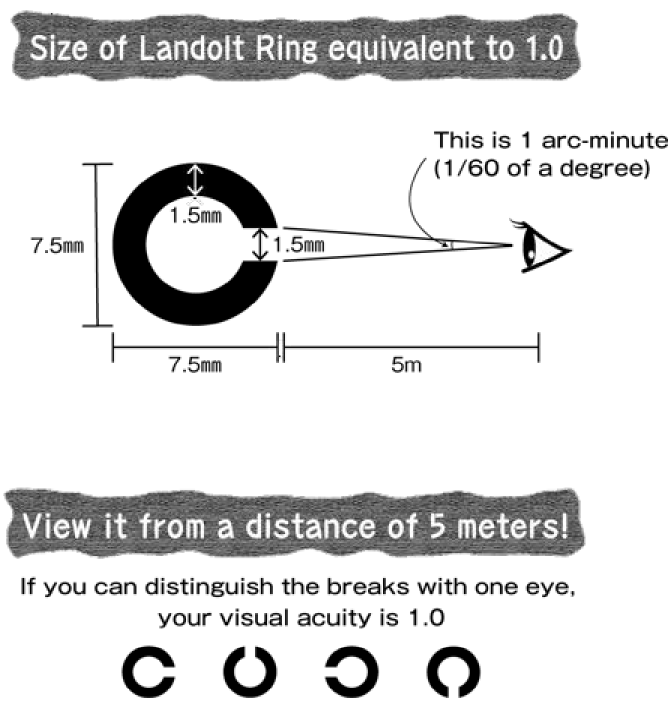
Cont

8. *Position displays or display elements so they have obvious spatial referents.*

- ***Legibility of Display Elements*** Cont

The size of a display or display element is the most basic issue addressed in legibility standards

9. *The minimum size of a critical detail should be 5 minutes of visual arc for novice observers and not less than 2 minutes of visual arc for experienced operators*



Design recommendations for alphanumeric characters vary anywhere from 10 to 30 minutes of arc, depending on the conditions addressed.

Cont

10.Symbols and alphanumeric characters should subtend a visual angle of at least 12 minutes of arc. When legibility is a primary concern, both should subtend visual angles of at least 16 to 25 minutes of arc. Characters should be in sans serif fonts, with character width-to-height ratios of 0.6:1 to 1:1.

11.Displays should provide an adequate contrast between visual elements and their background.

Cont

12. Avoid crowding of display elements.

13.Take steps to deal with the effects of degraded legibility due to aging and adverse environmental conditions.

- ***Principles related to Information Content and Coding***

14.Display instructions should whenever possible be stated in a positive manner

It is better to say, “Do this,” rather than, “Don’t Do That!”

15. Be selective.

- Providing excessive amounts of information on a display increases the time and effort needed to find what is relevant. If the provided information is difficult to read quickly, many people will ignore most or all of it

Cont

16. Let the user control the amount and detail of information presented.

17.Information about the current or desired state or condition of a system, item, or environment is more likely to be useful if the state or condition is (a) unusual, (b) has recently changed, (c) is likely to change, (d) is expected not to be known by the user of the display, or (e) is not easily observed.

18.Displays that make derivative information easily available make it easier for people to predict what will happen.

19.Be as realistic as possible in describing the variable you are trying to communicate.

Cont

20.The direction of movement of an indicator on a display should be compatible with the direction of movement in the operator's mental model of the variable whose change is indicated.

21.Color coding is a good tool for conveying relationships between display elements. Color also conveys a limited set of meanings in certain contexts.

22.Many coding schemes other than color, including shape, size, texturing, shading, and intensity can be effective.

23.Verbal and numerical codes tend to be better understood and require less learning than symbols or other coding methods.

Cont

24. ***The use of analogies and metaphors often can greatly improve the learnability and understandability of display elements.***

25. In most cases, line graphs are preferred slightly over vertical bar graphs and preferred strongly over horizontal bar graphs.

Cont

26.Multiple lines on a single graph are preferred over multiple single-line graphs in point reading and trend comparing tasks

27.Variations in pitch, amplitude, and modulation can be used to specify easily distinguished sounds. Some of these sounds convey stereotypical levels of perceived urgency.

ROLE OF DISPLAYS AND MACHINE CONTROLS

Displays and machine controls can play a critical role in human factors engineering by improving the efficiency, safety, and comfort of workers in a variety of settings.

Here are some specific examples of how displays and machine controls can enhance human factors engineering:

- **User-friendly interfaces:** Displays and machine controls can be designed to be user-friendly and intuitive, minimizing the need for extensive training and reducing the risk of errors.

- **Feedback and alerts:** Displays and machine controls can provide workers with real-time feedback and alerts, enabling them to make faster and more informed decisions and reducing the risk of accidents and errors.

- **Customizable settings**: Displays and machine controls can be designed to allow for customization of settings and preferences, enabling workers to tailor the system to their individual needs and preferences.

- **Ergonomic design**: Displays and machine controls can be designed with ergonomics in mind, reducing the risk of physical strain and discomfort and promoting overall wellbeing and comfort.

- **Accessibility:** Displays and machine controls can be designed to be accessible to workers with a wide range of physical abilities, ensuring that all workers are able to use the system effectively and safely.

By providing workers with user-friendly, customizable interfaces and real-time feedback, these tools can enhance efficiency, safety, and comfort, ultimately leading to a more productive and successful workplace.

Quantitative visual displays

Fixed scales with moving pointers

Moving scale with fixed pointers

Digital displays

Qualitative visual displays :

IMPROVEMENT OF HUMAN WORK PLACE THROUGH DISPLAYS AND MACHINE CONTROLS

There are several types of displays and machine controls **used to improve** the workplace and enhance human performance. Here are some examples:

- **Monitors**:

Monitors are used to display information in a clear and concise manner. They can be used for various purposes, such as monitoring production, displaying critical information, and providing feedback to workers.

- **Touchscreens:**

Touchscreens are intuitive and easy to use, and they can be used to control various machines and systems. They can be used in a wide range of applications, such as industrial automation, medical devices, and consumer electronics.

- **HMI (Human Machine Interface):** HMIs are used to interact with machines and systems, and they can provide visual and audio feedback to the user. They can be used for a wide range of applications, such as controlling industrial equipment, managing building automation systems, and operating medical devices.

- **Keyboards and mouse**: Keyboards and mouse are still widely used in many industries, and they can be used to input data into computers and control various machines and systems.

- **Augmented reality displa**ys: Augmented reality displays can provide workers with additional information and guidance when performing complex tasks. They can be used in a wide range of applications, such as manufacturing, maintenance, and assembly.

- **Voice-activated controls:**

Voice-activated controls can be used to control machines and systems, and they can be particularly useful in environments where hands-free operation is required, such as in clean rooms or hazardous environments.

- **Mobile devices**:

Mobile devices, such as smartphones and tablets, can be used to control various machines and systems remotely, providing workers with greater flexibility and mobility.

All of these displays and machine controls can be used to improve the workplace and enhance human performance, making tasks easier, faster, and more efficient.

SHAPES AND SIZES OF VARIOUS CONTROLS AND DISPALYS

There are many different shapes and sizes of controls and displays in machine control. Here are some common examples:

- **Push Buttons:** These are small buttons that can be pushed to activate a particular function. They come in various shapes, such as round, square, or rectangular.

- **Toggle Switches:** These are switches that can be flipped on or off. They often have a lever or handle that can be moved up or down. They come in various shapes, such as round, square, or rectangular.

- **Sliders:** These are controls that can be moved back and forth to adjust a particular setting. They often have a knob or lever that can be gripped to slide the control. They come in various shapes, such as straight or curved.

- **Rotary Controls:** These are controls that can be turned to adjust a particular setting. They often have a knob or handle that can be gripped to turn the control. They come in various shapes, such as round or square.

- **Touchscreens:** These are displays that allow the user to interact with the machine by touching icons or buttons on the screen. They come in various sizes, from small screens on handheld devices to large screens on control panels.

- **LCD Displays**: These are displays that show information such as numbers or letters. They come in various sizes, from small displays on handheld devices to large displays on control panels.

- **LED Displays**: These are displays that use light-emitting diodes to show information. They often have segments that light up to display numbers or letters. They come in various sizes, from small displays on handheld devices to large displays on control panels.

The shapes and sizes of controls and displays can vary depending on the specific application and the needs of the user. The important factor is that they are designed to be **intuitive and easy to use** for the user.

MULTIPLE DISPLAYS AND CONTROLS

Multiple displays and controls are often used in situations where there are **multiple functions or processes** that need to be monitored and controlled. Here are some examples:

- **Industrial Control Rooms**: In large factories or plants, there are often multiple processes that need to be monitored and controlled. A control room might have multiple displays showing information about each process, along with controls to adjust the settings.

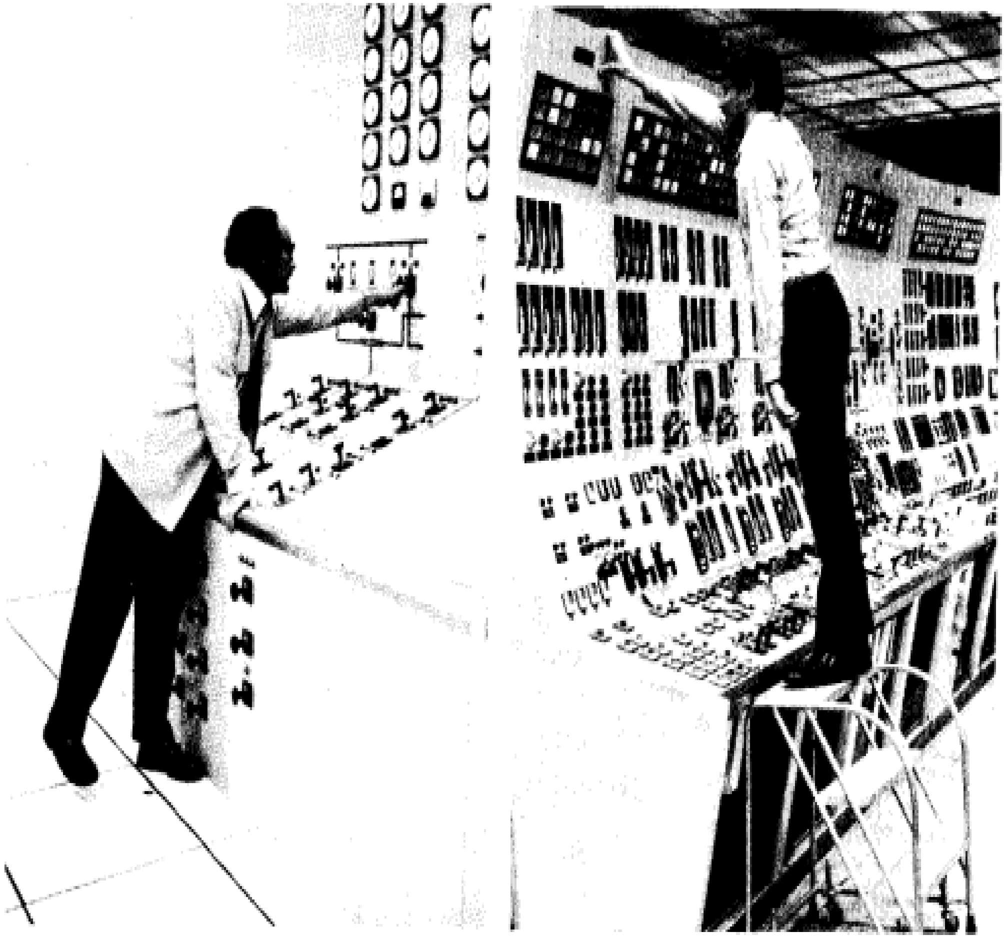
- **Flight Control Rooms:** In an airport control tower, there are multiple flights that need to be monitored and controlled. Multiple displays might show information about each flight, along with controls to adjust the flight path or altitude.

- **Medical Monitoring:** In a hospital, there are often multiple patients who need to be monitored. A nurse might use multiple displays to monitor each patient's vital signs, along with controls to adjust medication or other treatments.

- **Power Grid Management:** In a power plant, there are multiple generators and transmission lines that need to be monitored and controlled. Multiple displays might show information about each generator or transmission line, along with controls to adjust the settings.

In all of these situations, the goal is to provide the user with a clear and intuitive interface to monitor and control multiple processes at the same time.

The displays and controls should be designed to be easy to understand and use, with clear labels and intuitive controls.



A couple of human factors problems in a nuclear power plant. In the photograph on the left, the control console is arranged so that certain controls could be accidentally activated by the knee or the hand used to brace the operator when reaching for the farthest controls. In the photograph on the right, certain of the displays are at a height that makes reading or lamp replacement a problem. Special stepladders are required. *(Copyright 1979, Electric Power Research Institute, EPRI Report NP-1118, "Human Factors Methods for Nuclear Control Room Design." Reprinted with permission.)*

DESIGN OF MAJOR CONTROLS IN AUTOMOBILES

Steering Wheel: The steering wheel is the primary control for directing the vehicle's movement. It must be easy to grip and maneuver while providing enough feedback to the driver to maintain control of the car.

Accelerator Pedal: The accelerator pedal is used to control the speed of the vehicle. It must be placed in a position where the driver can easily reach it, and it should have a smooth and responsive action.

Brake Pedal: The brake pedal is used to slow down or stop the vehicle. It should be positioned in a way that allows the driver to apply sufficient pressure without having to stretch too far.

(cont..)

Gear Shift: The gear shift is used to select the appropriate gear for the driving conditions. It should be easy to reach and operate, and it should have a clear and easy-to-understand layout.

Dashboard Controls: Dashboard controls include various buttons and switches that control the car's lights, wipers, radio, and other features. These controls should be easy to reach and operate, with clear labeling and intuitive placement.

DESIGN OF MAJOR CONTROLS IN MACHINE TOOLS

Power Switch: The power switch is used to turn the machine tool on and off. It should be easy to locate and operate, with clear labeling and safety features to prevent accidental startup.

Spindle Control: The spindle control is used to control the speed and direction of the cutting tool. It should be easy to adjust and operate, with clear markings and feedback to ensure precise control.

Feed Control: The feed control is used to control the movement of the workpiece and cutting tool. It should be easy to adjust and operate, with clear markings and feedback to ensure precise control.

(cont..)

Emergency Stop: The emergency stop button is a critical safety feature that immediately stops the machine tool in case of an emergency. It should be easy to locate and operate, with clear labeling and safety features to prevent accidental activation.

Display and Feedback: The machine tool should provide clear and accurate feedback on the various settings and operations, including speed, feed rate, and cutting depth. The display should be easy to read and interpret, with clear markings and color coding to help the operator quickly identify key information.

ERGONOMIC PRINCIPLES FOR HAND TOOLS

- **Hand tools** should be designed according to ergonomic requirements. Poorly designed hand tools, or tools that do not fit the individual worker or the task can cause negative health effects and decrease a worker's productivity.
- In order to prevent health problems, as well as to maintain the worker's productivity, hand tools should be **designed so that** they fit both the individual and the task.
- Well designed tools can contribute to **good body positions** and **movements** and can increase productivity.

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<u>Use the following guidelines when selecting hand tools:</u>

- **Avoid poor quality** hand tools.
- **Choose tools** that allow the worker to use the larger muscles in the shoulders, arms and legs, rather than the smaller muscles in the wrists and fingers.
- **Avoid** holding a tool continuously in a raised position or gripping a heavy tool.
- **Properly designed tools** allow the worker to keep the elbows next to the body to prevent damage to the shoulder or arm. Additionally, properly designed tools do not require the worker to bend the wrists, stoop or twist.

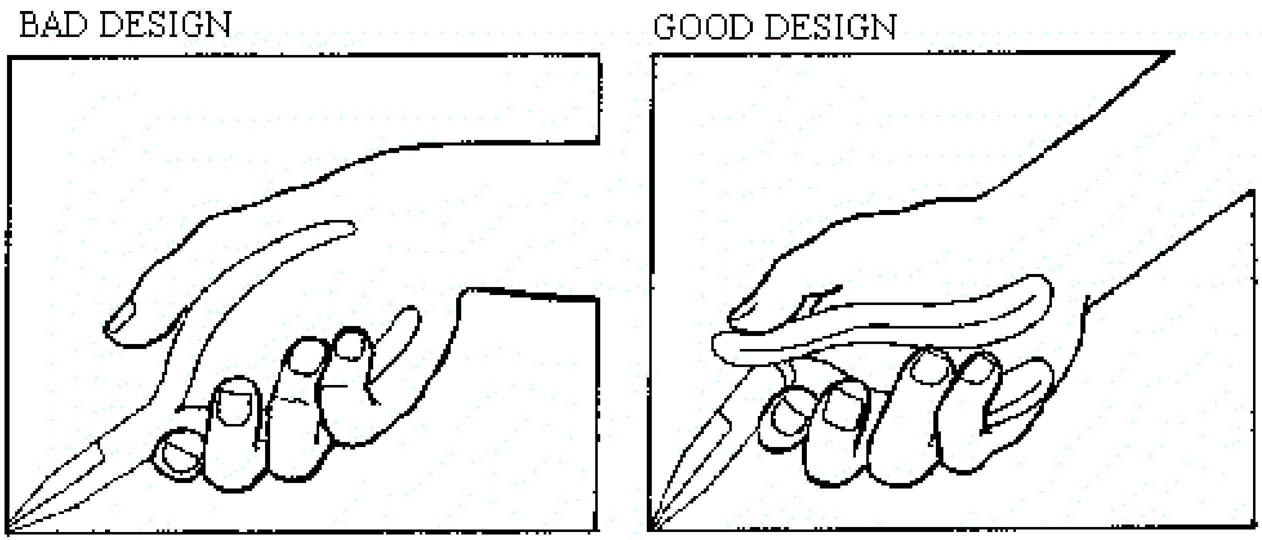
(CONT…)

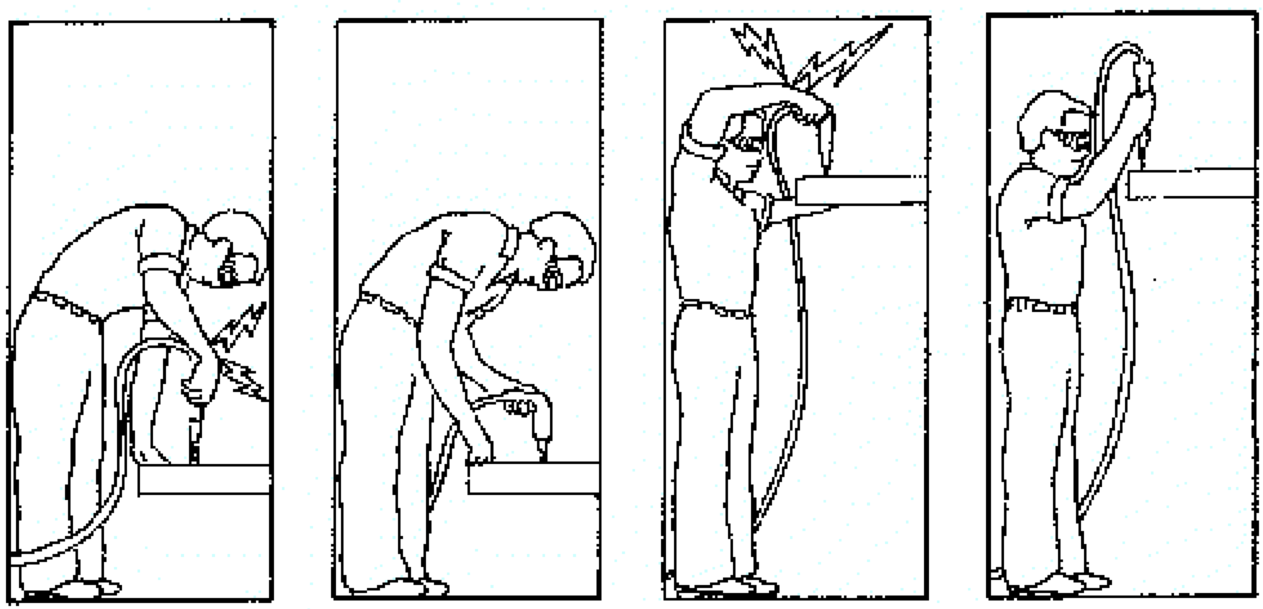
- **Choose handles** that are long enough to fit the whole hand. This will help to reduce uncomfortable pressure on the palm of the hand or on the joints of the fingers and hand.
- Do not use **tools with spaces** where fingers and skin can get caught.
- Choose **double-handled tools**, such as scissors, pliers or clippers. These should have a span that does not overstretch the hand.
- Do not select tools with contoured handles; they **fit only one size** of hand and put pressure on hands they do not fit.

(CONT…)

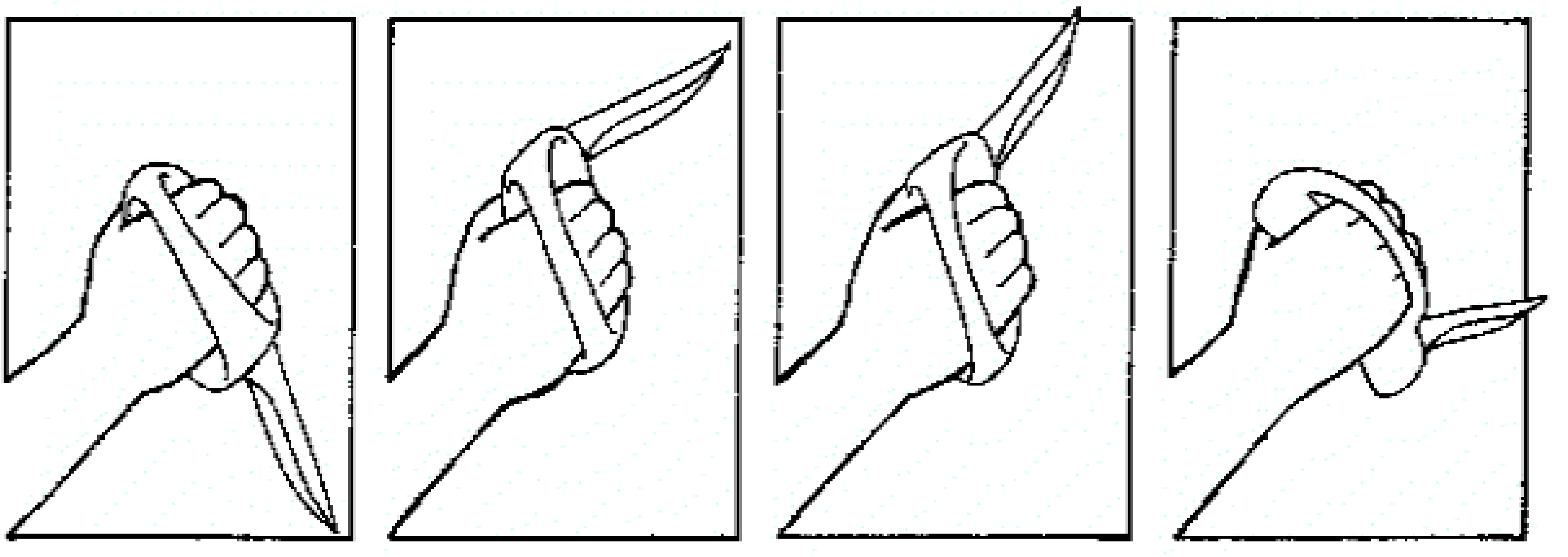
- Make **tool handles easy to grip**. Handles should also have good electrical insulation and they should not have any sharp edges or sharp corners. Put **soft plastic covers** on handgrips to reduce slipperiness.
- **Avoid using tools** that force the wrist to bend or to be in an awkward position. Redesign tools so that the tool bends and not the wrist.
- Choose tools with an **evenly balanced weight** and make sure they are used in the proper position.
- Make sure tools are **properly maintained**.
- Tools should be appropriate for **right- or left-handed** workers.

These pictures illustrate how tool design can prevent you having to work with a bent wrist.

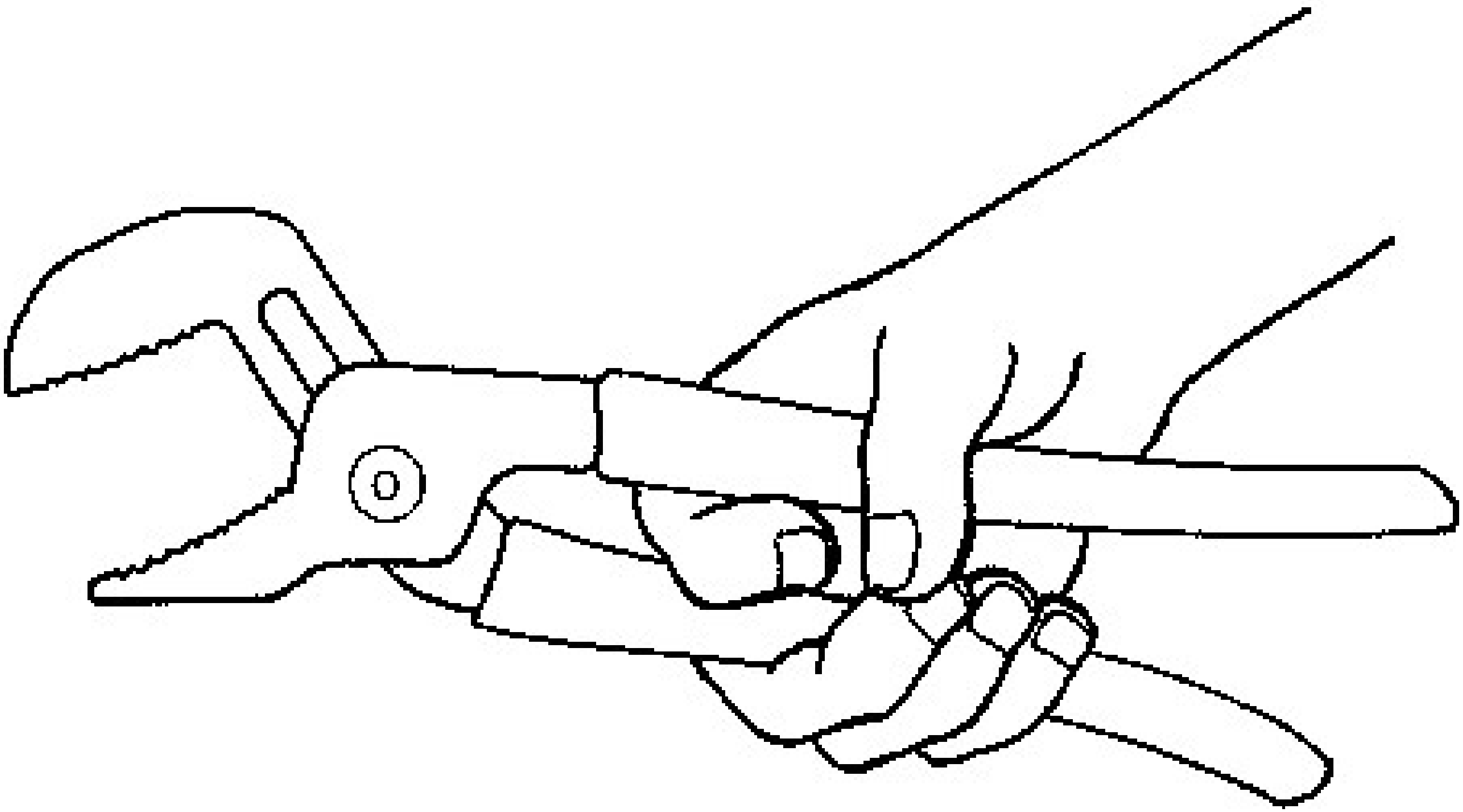




In a Poultry processing plant a variety of special knife handles were developed so that each cut could be made with straight wrist

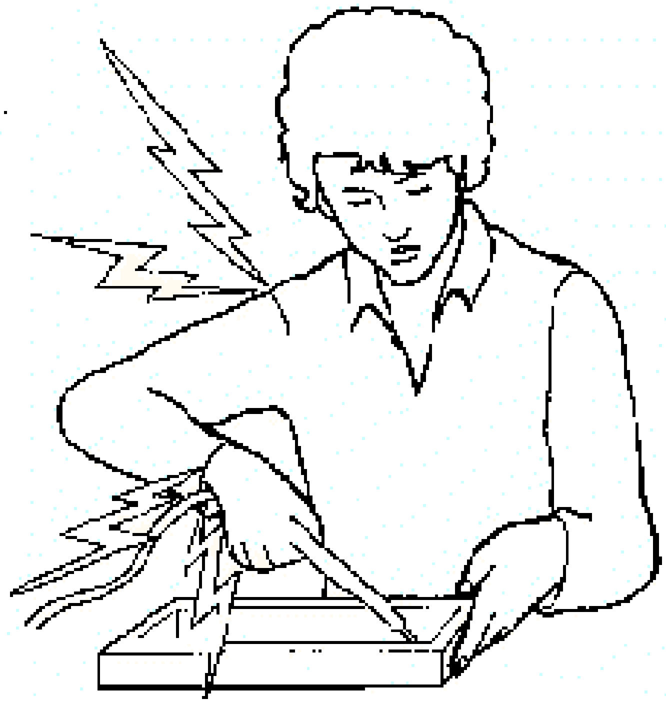


Do not use tools with spaces that can catch fingers or flesh.



IN SOME CASES TOOLS CAN BE CHANGED TO KEEP THE ARMS LOW AND ELBOWS IN

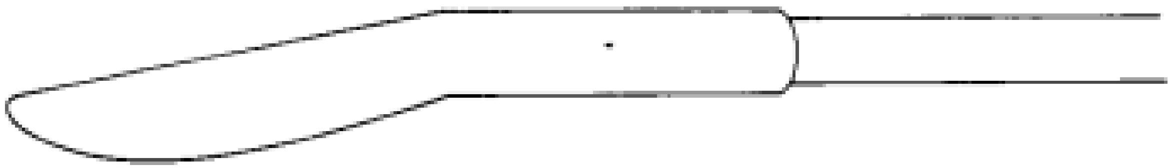
BAD DESIGN



SOLDERING IRON WITH BENT HANDLE ALLOWS ELBOW TO BE LOWERED AND WRIST STRAIGHTENED

GOOD DESIGN

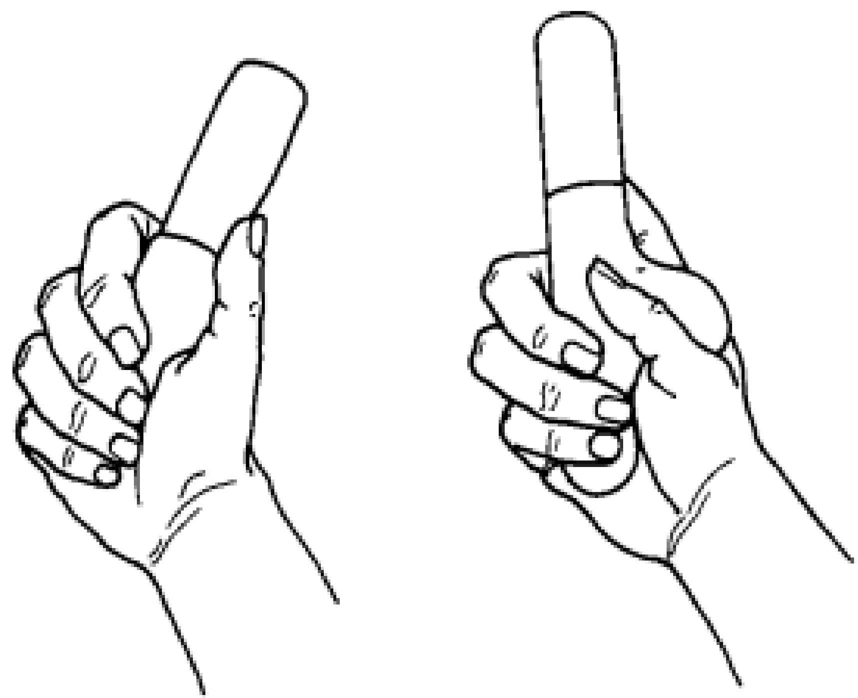
Examples of the Bent handle that helps the user keep the wrist straight while using the tool



(a) Broom handle

(b) Hammer handle

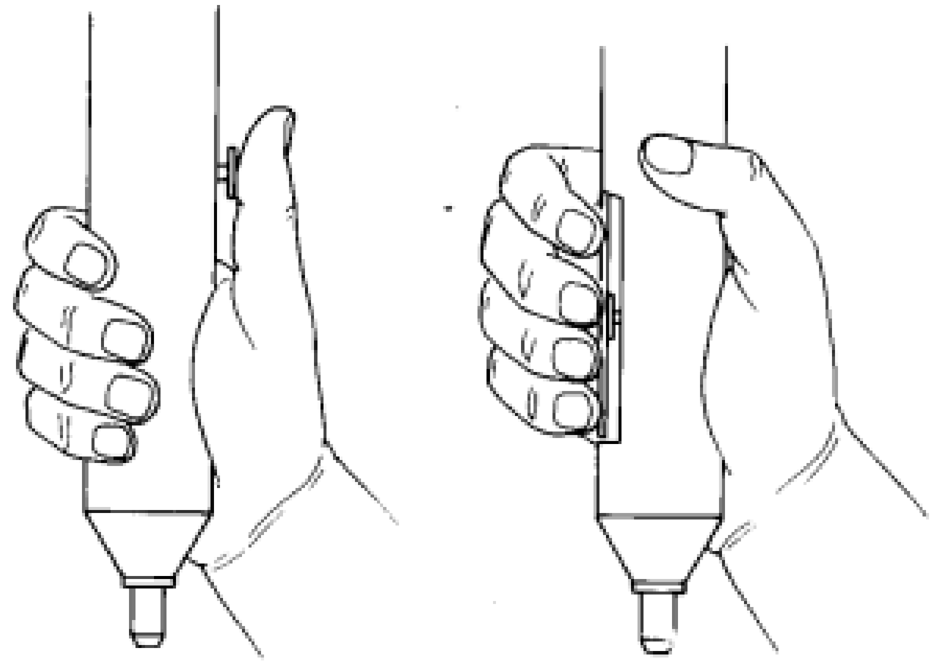
A conventional paint scraper that presses on the ulnar artery, and a modified handle which rests on the tough tissues between thumb and index finger, thus preventing pressure on the critical areas of the hand



(a) Conventional handle (b) Modified handle

Thumb-operated and finger-strip-operated pneumatic tool. Thumb operation results in over extension of the thumb.

Finger-strip control allows all the fingers to share the load and thumb to grip and guide the tool.



(a) Thumb switch (b) Recessed finger strip

WORK PLACE AND SEATING DESIGN

- A ***work-space envelope*** is the three-dimensional space within which an individual works. Typically this boils down to the space within which the hands are used.
- Within this envelope, controls and displays are to be placed
- Workplace design is the process of creating and optimizing physical and virtual environments to support the work activities of individuals and teams.
- Effective workplace design can increase productivity, creativity, collaboration, and employee satisfaction.

Key elements to consider when designing a workplace

Space planning: The layout of the workplace should be carefully planned to optimize the use of space and support the work activities of individuals and teams

Lighting: Adequate lighting is essential for employee comfort and productivity. Natural light is preferred, but artificial lighting should be designed to mimic natural light as much as possible.

Furniture: Ergonomic furniture is important to support employee health and comfort. Desks, chairs, and other furniture should be adjustable to accommodate different body types and work styles

Technology: Technology plays a key role in modern workplaces. The workplace should be designed to accommodate the latest technology, such as computers, mobile devices, and video conferencing equipment

Cont ..

Color and aesthetics: The colors and aesthetics of the workplace can have a significant impact on employee mood and productivity. Calming colors, such as blues and greens, are often preferred

Noise control: Excessive noise can be a distraction and reduce employee productivity. The workplace should be designed to minimize noise, with sound-absorbing materials and strategic placement of equipment.

Collaborative spaces: Collaborative spaces are important for team- based work. These spaces should be designed to support collaboration and creativity, with comfortable seating, whiteboards, and other tools

DESIGN OF OFFICE FURNITURE

Adjustable furniture is fundamental to good human factors design. Studies have shown that providing adjustable seats increases productivity

Guidelines for increasing the ease of making adjustments:

- Controls can be easily reached and adjusted from the standard seated work position.
- Labels and instructions on the furniture are easy to understand.
- Controls are easy to find and interpret.
- Tools are not necessary.
- Controls provide immediate feedback
- The direction of operation of controls is logical and consistent.
- Few motions are required to use the controls.
- Adjustments require the use of only one hand

DESIGN OF OFFICE CHAIR

Adjustability: A good office chair should be adjustable to accommodate different body types and work styles. Key features to consider include adjustable seat height, tilt tension, and lumbar support.

Seat cushioning: A comfortable seat cushion is essential for reducing pressure on the lower back, hips, and thighs. The seat cushion should be firm enough to provide support but not so firm as to cause discomfort.

Backrest design: The backrest should be adjustable to support the natural curvature of the spine. The angle and height of the backrest should be adj

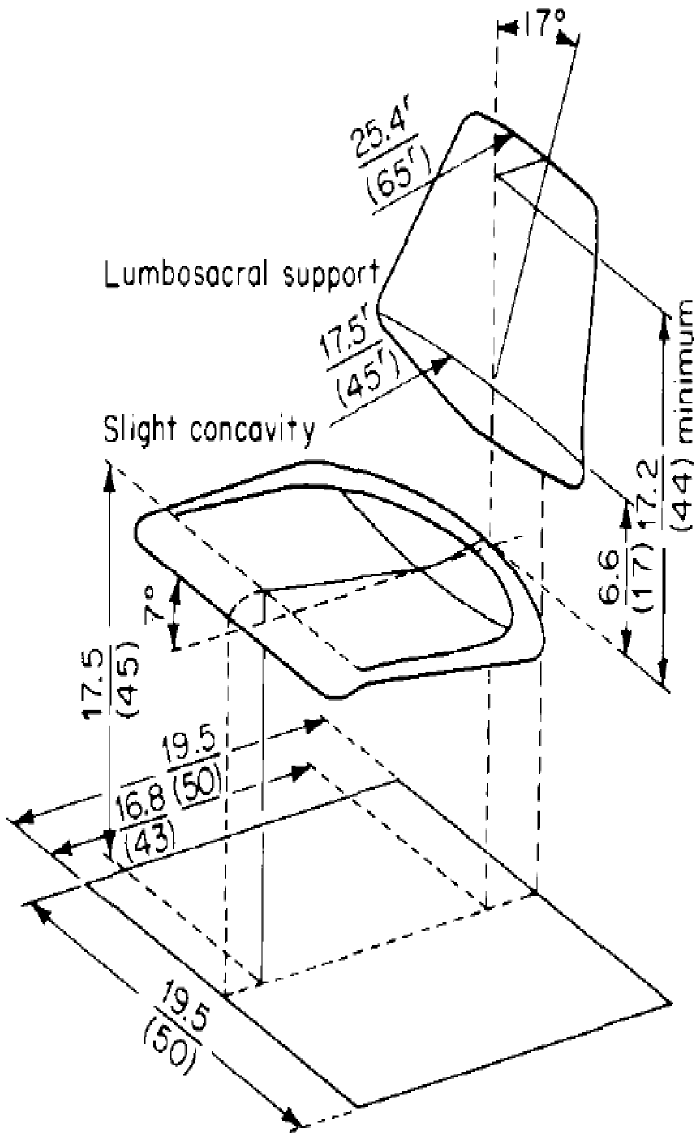
Armrests: Armrests are important for reducing strain on the neck and shoulders. The armrests should be adjustable to accommodate different work styles and body typesustable to accommodate different body types

Cont ..

Swivel base: A swivel base is important for allowing the user to easily turn and reach different areas of the workspace

Material and durability: The material used to construct the office chair should be durable and easy to clean.
Mesh and leather are common materials used in office chairs

Aesthetics: The design of the office chair should be aesthetically pleasing and complement the overall design of the workplace.



Design features of multi purpose chair

RANGES OF DIMENSIONS OF SEATS FOR READING AND RESTING PREFERRED BY SUBJECTS

Dimension	Reading	Resting
Seat inclination, deg	23-24	25-26
Backrest inclination, deg	101-104	105-108
Seat height, cm	39-40	37-38
Seat height, in	15.3-15.7	14.6-15.0

Source: Grandjean, Bani, and Krestzschmer, 1969.

Design of video display terminal workstations

Ergonomics: The workstation should be designed to minimize physical discomfort and repetitive stress injuries. Key features include an adjustable chair, adjustable keyboard tray and monitor height, and adjustable lighting.

Visual comfort: The workstation should be designed to reduce eye strain and visual fatigue. Key features include a non-glare monitor screen, adjustable monitor distance and angle, and proper lighting that is not too bright or too dim.

Task performance: The workstation should be designed to optimize task performance, such as by providing sufficient desk space for documents, tools, and other materials that may be needed during computer use.

CONT..

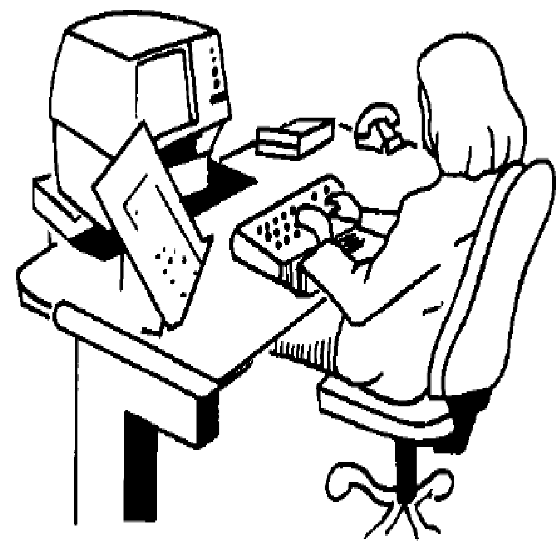
Cable management: Cables should be organized and secured to reduce tripping hazards and ensure that the workstation is tidy and safe

Ventilation: The workstation should be designed to allow for adequate ventilation to prevent overheating of equipment

RECOMMENDATIONS FOR VDT WORKSTATION ADJUSTMENT RANGES FOR KEYBOARD AND TERMINAL

CONT..

Dimension	Human Factors Society 1988	Lueder 1986a
Keyboard height (IloOr to home row)	23-28 in (58.5-71 em)	24-32 in (61-81.5 em)
Keyboard angle	0-25°	0-25°
Screen position		
Angle below horizon	0-60°	
Support surface height		24.4-35 in (62-89 em)
Screen angle to vertical		
Ideal		+/- 20°
Minimum		+/- r



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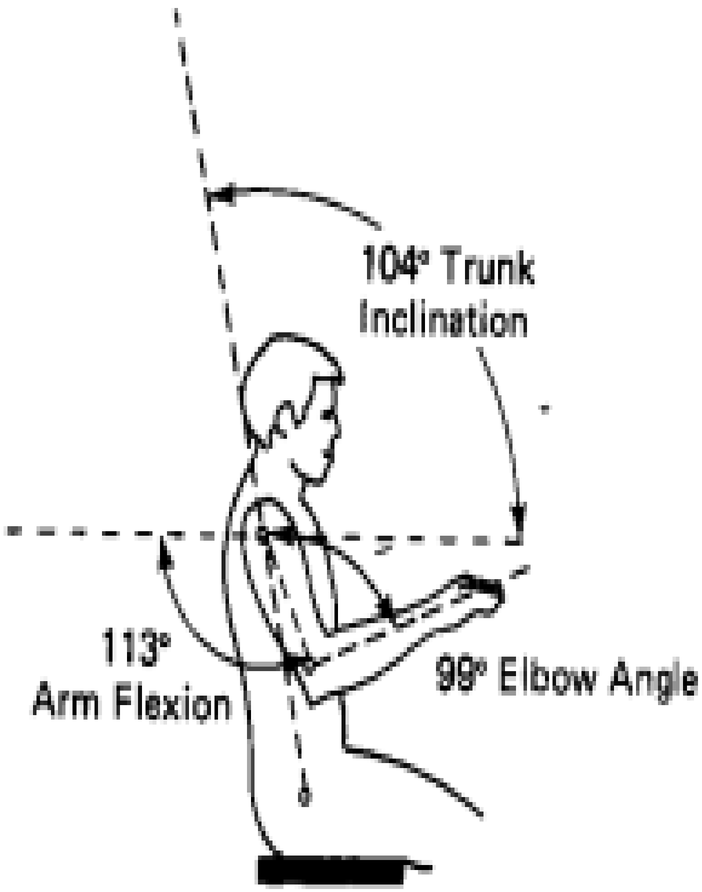
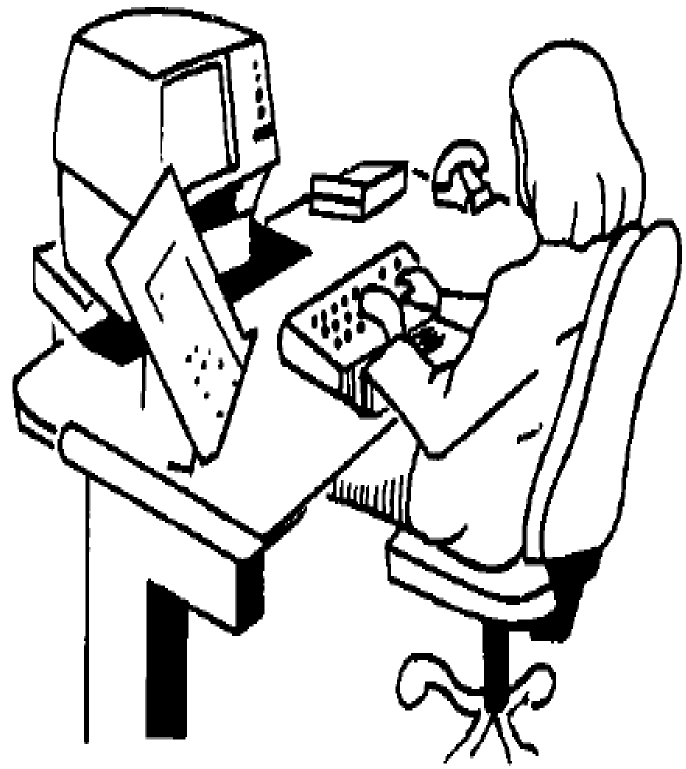




RE DESIGN OF INSTRUMENTS

- **Redesigning instruments** in the workplace is a critical aspect of human factors engineering, which involves optimizing the design of tools, equipment, and systems to enhance their **usability, efficiency, and safety**.

- It requires a thorough understanding of the **user's needs**, the environment in which the instrument is used, and the tasks it is intended to perform.

Some key considerations in redesigning instruments are:

- **User interface**: Redesigning the user interface involves making the controls and displays more intuitive, easier to use, and more ergonomic.

- **Safety features**: Safety is a crucial consideration in redesigning instruments. Incorporating safety features can reduce the risk of accidents and injuries.

For example, adding sensors to a machine that detect the proximity of other objects, or adding a safety switch to prevent the instrument from operating when it is not in the correct position.

- **Ergonomics:** Ergonomics refers to the design of the instrument to fit the user's physical and cognitive capabilities. Redesigning instruments for ergonomics involves making them more comfortable to use for extended periods and reducing the risk of injury.

For example, redesigning the shape of a handle to make it easier to grip or adjusting the height of a workstation to reduce strain on the user's back.

- **Environment:** The environment in which the instrument is used can impact its usability and safety. Redesigning instruments for the environment involves taking into account factors such as lighting, temperature, and noise levels.

For example, redesigning the display of a system to be visible in low-light conditions or adding insulation to a machine to reduce noise levels.

CONT..

In summary, **redesigning instruments** in the workplace requires a holistic approach that considers the **user, the environment**, and **the tasks** the instrument is intended to perform.

By incorporating human factors engineering principles such as user interface design, safety features, ergonomics, and environmental considerations, the instrument can be redesigned to be **more efficient, safer, and easier to use**.

CONT..

An example of redesigning instruments in the workplace:

Let's consider a manufacturing facility that uses a **hydraulic press** to shape metal parts. The hydraulic press requires a user to push a button to **activate the press**, which shapes the metal parts. However, accidents occur when the user's hands are caught in the press.

To address this issue, an HFE engineer could **redesign the hydraulic press** by incorporating **safety features** such as light curtains that detect the user's hands and prevent the press from operating when the user's hands are in the press.

Additionally, **the button** to activate the press could be placed in a location that is harder to accidentally press, such as on the side of the press, rather than on the front.

CONT..

HYDRAULIC MACHINE PRESS

The **user interface** could be redesigned by adding visual feedback to the press, such as a display that shows the status of the press, whether it is on or off, and whether it is safe to operate.

The **labels on the buttons** could be made more visible, and the buttons could be designed to be more ergonomic, making them easier to **use for extended periods**.

The **environment in which the hydraulic press** is used could also be considered. For example, the press may be used in a **noisy environment**, so the redesign could include adding features that make it easier to use in noisy conditions, such as an audio feedback system that confirms the press's operation.

CONT..

HYDRAULIC MACHINE PRESS

METAL PARTS PRODUCED BY HYDRAULIC MACHINE PRESS

WORK PROCESS

A work process refers to a series of steps or tasks that are carried out to accomplish a specific goal or objective.

It is a structured and systematic approach that outlines how work should be done in order to achieve a desired outcome.

Work processes can vary depending on the industry, organization, or type of work being done, but they generally involve the following elements:

CONT…

Planning: This involves defining the goals, objectives, and requirements of the work process. It may also involve identifying the resources needed to carry out the work.

Execution: This is the actual implementation of the work process. It involves carrying out the tasks and activities that have been planned in order to achieve the desired outcome.

Monitoring: This involves keeping track of the progress of the work process to ensure that it is on track and that any issues or problems are identified and addressed in a timely manner.

Evaluation: This is the process of reviewing the work process after it has been completed to determine its effectiveness and identify any areas for improvement.

CONT….

Improvement: Based on the evaluation, improvements can be made to the work process to optimize its efficiency and effectiveness for future implementation.

Overall, work processes are critical to achieving organizational goals and objectives, as they provide a structured and systematic approach to work that ensures consistency, efficiency, and effectiveness in achieving **desired outcomes**.

DURATION OF REST PERIODS

- **Rest periods** refer to the **amount of time** a person takes a break from work or physical activity to allow their body to recover and rejuvenate.

- The duration of rest periods can vary depending on the type of activity being performed, the individual's fitness level, and their overall health.

- In general, rest periods should be long enough to allow the body to recover, but not so long that the person loses their momentum or motivation.

- For most physical activities, including weightlifting, running, or high-intensity interval training (HIIT), rest periods between 30 seconds to two minutes are common

CONT…

- For **office workers** or those engaged in sedentary work, it is important to take frequent breaks to avoid sitting for long periods, which can be harmful to health. Taking a break for a few minutes every hour can help to reduce the risk of developing back pain, eye strain, and other health issues related to prolonged sitting.

- When it comes to **sleep**, it is recommended that adults aim for 7-9 hours of sleep per night to allow their body to rest and recover. Adequate sleep is essential for maintaining good health, cognitive function, and emotional well-being.

CONT…

- **Workday breaks** are breaks organized during the working day by pausing the work for the purpose of resting, eating or other needs.

- **Daily rest** is provided after the end of the working day. This is the uninterrupted rest period between two shifts within a twenty-four hour period.

- **Weekly rest** refers to a minimum break of 24 consecutive hours (1 day) from work within a seven day period.

- **Annual leave** is a yearly vacation or holiday, consisting of consecutive days or weeks off work, which may be paid.

CONT…


Workday breaks
Coffee break
Meal break
Coffee break
8/10/12/... hours
Daily rest
24 hours
10/11/12/... hours
Weekly rest
7 days
Weekend (1/1,5/2 days)
Annual leave
12 months
Annual leave

VISUAL DISPLAYS

- A visual display is a device that presents information about objects, events or situations, to us through our eyes.
- Sometimes the display will be used in addition to information gained by observing the event or situation directly, but in some circumstances the display may be the only source of information available to us.
- Examples include TV, your computer screen, thermometers, car instruments, charts, graphs, maps and other forms of printed or written material.

Visual displays

EFFECTIVE VISUAL DISPLAYS

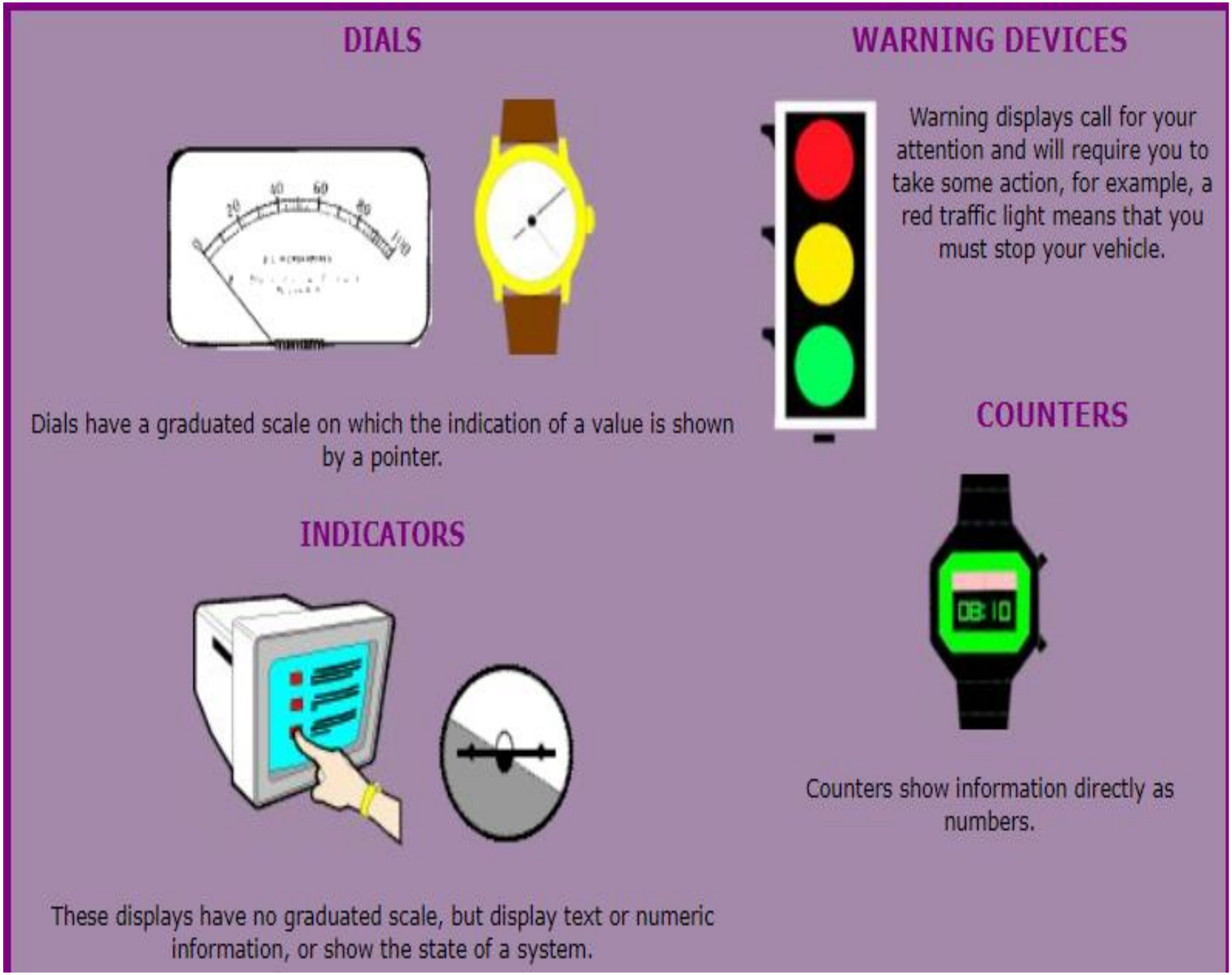
Displays will generally be effective if they have:

- **Good *visibility*** - you can easily and clearly see the displays. To attract attention visually, the display must be within your field of vision and should flash or change in some other way. Humans are very good at detecting movement.

- **Good *comprehension*** – you can make the correct decisions and control actions with minimum effort and delay, and with as few errors as possible, because you have understood the displayed information.

- **Good *compatibility*** - the display can be used easily with others and you are not confused by any different types used. It can easily be seen and understood in the space and lighting in which it is used. The movement and layout of displays matches those of their controls.

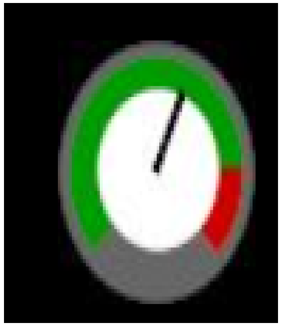
TYPES OF DISPLAYS



Quantitative displays

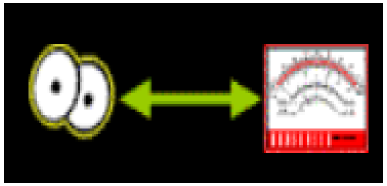
- The scale must be legible and you should avoid multiple or non-linear scales. Scale numbers, marking strokes, pointers, etc., should contrast well in tone and colour with the display face.
- This should be combined with good illumination and the absence of glare or reflections.
- You should also position the dial near eye level and approximately at 90 degrees to your angle of view. Scale numbers should increase clockwise, left to right, or upward.

Qualitative displays



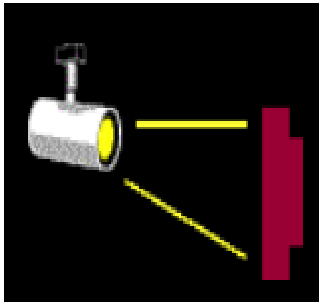
- Each of the displayed conditions should be as distinctive as possible, through differences in position, colour, shape or size on the display.
- You should integrate more than one of these means on the display, for example, by using lights combined with a change in position of the indicator. The fuel gauge in a car might, for example, flash when the tank is nearly empty.
- The different rings on an office phone for internal and external calls is another example of a qualitative alarm.

DESIGN GUIDELINES FOR DISPLAYS



- **Viewing distance**:

The maximum display viewing distance should be determined by the size of details shown on a display. The reading distance for displays is usually 300-750mm, as many displays have to be read at arm's length and must allow to reach or adjust controls. Displays must be optimally positioned within our field of view.



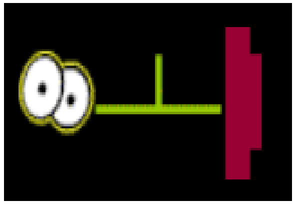
- **Illumination**

  Displays may have their own internal or back-lighting, but if not, their design should be suited to the lowest expected lighting level.

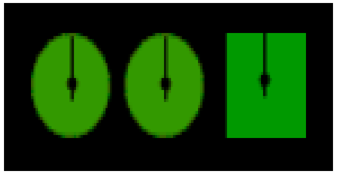
Cont..

- **Angle of View:**

The preferred angle of view for displays (the angle at which the display plane is positioned with regard to the person monitoring it should be 90 degrees.



This is especially important with large picture displays as positioning them at an angle may cause parts of the display to be hidden from your eyes.



- **Combination of Displays:**

For these complex displays you will almost invariably have to divide attention between a number of tasks, as well as the displays themselves. Any inconsistencies in the manner of information-representation among the displays will be confusing, and will reduce your speed of reaction to a change indicated by a display, or even cause reading or decision errors.

Cont..

- **Compatibility with related controls:**

Displays and their associated controls should be designed and located so that you can select the correct control and operate it effectively and without error

GENERAL DESIGN CHECKLIST FOR DISPLAYS

- What is the overall objective of the display?
- What information is needed to support the objective?
- What is important about the displayed information?
- Is the information used directly with other information?
- What type of technology will be used for the display (mechanical, electrical)?
- What levels of details and accuracy are required for the displayed information?
- How often will the information change?

Cont..

- Does the display need to be continuously monitored?
- Is the display output directly influenced by operator input?
- Under what environmental conditions will the display be used/viewed (lighting, noise, distance)?
- What else will the operator be doing while viewing the displays?
- What are the physical and cognitive characteristics of the operators?
- With what other equipment will the display be housed/viewed?
- What sort of errors are likely to be made by the operator? Does the design help to reduce them?

DESIGN FOR SHIFT WORK

Recommendations for the design of shift systems

- **Night work** should be reduced as much as possible. If this is not possible, quickly rotating shift systems are preferable to slowly rotating ones. Permanent night work does not seem to be recommendable for the majority of shift workers.

- **Extended workdays** (9–12 hours) should only be contemplated when the nature of work and the workload are suitable for extended working hours, and the shift system is designed to minimize the accumulation of fatigue and toxic exposure is limited.

CONT..

- **An early start** for the morning shift should be avoided. Flexible working time arrangements can be achieved in all shift systems. The highest flexibility is possible in the so-called ‘time autonomous groups’.

- **Quick changeovers** (e.g. from night shift to afternoon shift on the same day) should be avoided. The number of consecutive working days should be limited to five—seven. Every shift system should include some free weekends with at least two consecutive days off.

- **The forward rotation** (phase delay, clockwise rotation: morning/evening/night shift) would seem to be most preferred.