1) DESIGN OF VISUAL DISPLAYS:-

The design of displays and controls of a machine can either facilitate interaction or increase task difficulty and the probability of error. The Gestalt psychologists from Germany identified a number of laws by which the perpetual system was organised. They are the following:-

a) FIGURE GROUND DIFFERENTIATION:-

→ It is a fundamental step in perpetual processing in which.

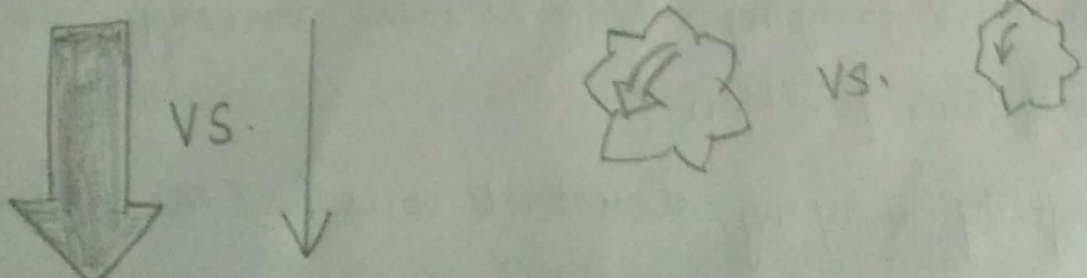
a) The perceived figure has form while the background is formless.

b) The figure appears to standout against the background.

→ Since the perpetual system is of limited capacity, this process is seen as a way of reducing incoming data to manageable proportions.

→ Ground info provides a context that influences the way in which the figure is perceived, so ground info is processed at physical level.

Eg:- In advertising, journalism and Reports the use of typical typefaces can influence the way a message is interpreted.



STRONG CONTOUR IMAGE DIFFERENTIATION.

→ Contour is a characteristic of a stimulus array that provides cues for this. Sudden chromatic changes are the epicenter for natural contour between objects.

→ Closure is the rendering of form - a tendency to complete or close a figure. It is the tendency to produce a meaningful percept from incomplete cues and it prevents us from being aware of the effects of the retinal blind spot on vision.

→ closure depends heavily on skills and experience.

b) GROUPING :-

→ Grouping describes basic perpetual principles that determine how an array of separate elements is grouped to form a complete percept.

→ According Rock & Palmer, these laws have general applicability.

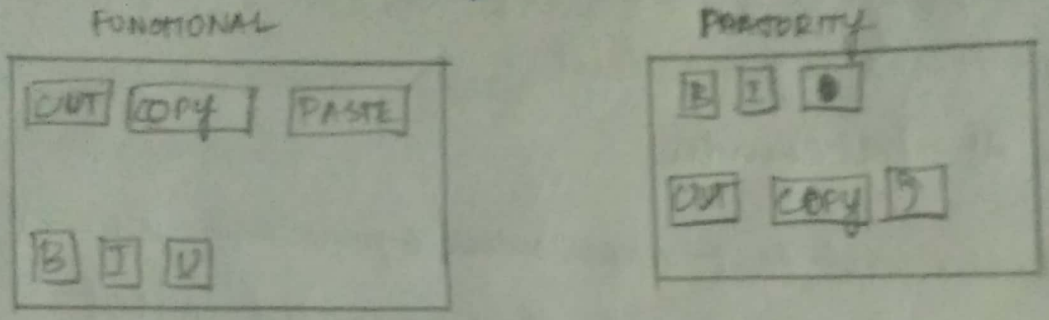
→ Good mapping between display layouts and system functions can increase the efficiency of visual scanning. Kotval and Goldbag compared eye movement of subjects scanning the icons.

→ In functional grouping, the icons were arranged on the basis of their function.

→ In majority grouping, almost all icons had the same function except a few.

→ In physical grouping, the icons were clustered into groups irrespective of their function.

→ There was also a no grouping function in which all icons were equally spaced.



c) COLOUR:-

→ Colour is used to provide contextual grouping of text.

Eg:- In a timetable, time, period can have different colour schemes.

→ Red indicates danger, go represents by green, amber signifies caution. But 5-8% do have colour blindness.

→ The use of unsaturated colours can help to improve the discriminability of coloured signals for colour blind users. Difference in wavelength of colours can improve discriminability.

d) RESOLUTION OF DETAIL ⟹ RESOLUTION OF DETAIL

→ The ability to resolve detail depends on the accomodation of the eye's lens, the ambient lighting and the visual angle.

→ Visual angle takes the absolute object size because it takes into account object size and viewer distance.

$$\text{Size at new distance} = \frac{\text{Size of Reference} \times \text{New distance}}{\text{Reference Distance}}$$

→ colour coded dials help users to memorize the numbers and reduce load on memory for routine tasks.

→ Digital displays is needed where accurate reading of quantities is prevalent.

Eg :- At a bill counter.

→ It was observed that experienced operators became familiar with the panels they operated most frequently.

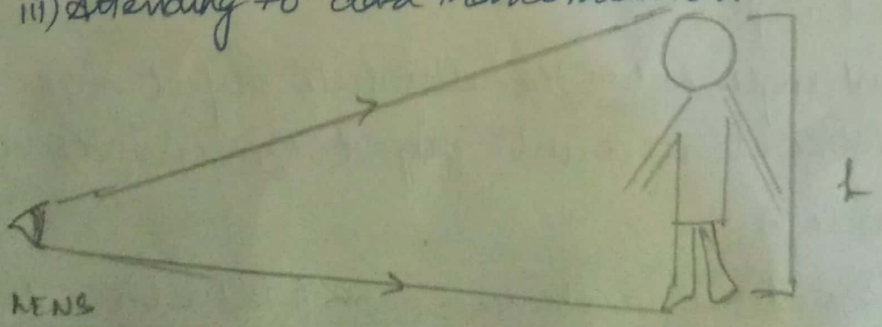
⇒ Common criteria for layout of complex panels includes the elimination of unnecessary or complex movements, Reduction of movement complexity, encourage muscle memory, Avoid spatial transformations etc.

→ In complex displays, the process is decomposed into number of stages :-

i) Alerting operators to the existence of signal or target data

ii) Orienting the perpetual system to the appropriate part of the display.

iii) Attending to data transmission.



f) THREE DIMENSIONAL DISPLAYS:

→ A 3D world is spontaneous and depends on cues for senses. They are used for designing simulators and for development of 3D structures.

→ Monocular depth cues can be detected using one eye but are also operative when both eyes are used:-

Accomodation - Proprioceptive feedback from ciliary muscles.

Movement Parallax - Depth perception influenced by head movements.

Interposition - A near object, interposed between a more distant one.

Relative Size - The size of the retinal image can be used as a cue if object size is known.

Texture Gradient - Change of texture as distance increases.

Linear perspective - used by artists for a 3D cue whilst painting.

Casting of shadows - A light source near the objects makes them cast a shadow far away.

Retinal disparity - The difference in retinal images is called stereopsis. Used as a cue for depth. As distance increases, the two eyes tend to the parallel and retinal disparity diminishes.

Convergence - Kinaesthetic feedback from the vergence system, is a cue upto 15 metres.

e) COMPUTER GENERATED DISPLAYS :-

→ Screen based displays offer flexibility and innovative graphical techniques for representing state changes compatible with operator changes.

→ The displays can be updated with state changes.

→ The system must pursue a direct representation of system state. Speed and accuracy of the system was

→ Computer systems are trained to display information pertinent to the current task.

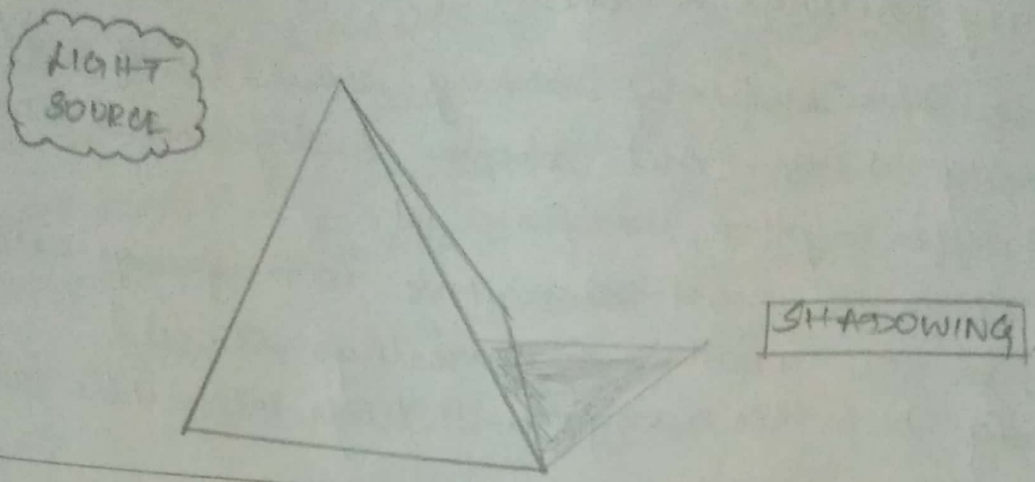
→ A common approach to solve this design problem is to use icons. An icon is a symbolic representation of an object

→ The problem of getting lost in large databases is aggravated when the system is incorrect or incomplete. Beard & Walker proposed a tree structure to hierarchially represent large data.

→ We can access large data using analogy - which helps to convey ideas expressed at several levels of activity.

→ Hypertext systems are databases that contain items of information stored non-sequentially. They are n-dimensional in sense.

→ Maps and Navigations aids are needed for users to find the path to their destination using computer generated displays.



2. DESIGN OF AUDITORY DISPLAYS :-

→ The design of auditory displays varies as per the following types :-

a) SYNTHETIC SPEECH :-

→ Voice input to humans is possible and is a potentially very powerful display modality.

→ Cowley and Jones have reviewed some of the ergonomic aspects of the use of computer speech and compared the pros and cons of digitised Vs. synthesised speech.

→ Synthesised speech is less intelligible than digitised speech but may be more flexible.

→ Words at the end of an utterance were less likely, to misunderstood than words at the beginning. Speaking rates of less than 250 words / minute were found preferable for novice users.

→ Speech is hence a valuable form of display in situations where it is necessary to block the error transmission of errors

b) AUDITORY WARNINGS AND USES:-

→ An effective auditory warning should be of sufficient intensity to stand out above background noise and differ in pitch, waveform etc.,

→ The ear is the most insensitive to the frequency range 500–3000 Hz, so warnings should ideally be in this range with high intensities at the lower frequencies.

→ Warnings should not be so excessively loud as to increase worker's daily noise dose above acceptable levels.

→ Sirens were judged to be compatible with industries. Horns were compatible with machines. Alarms were compatible to fire & vehicles.

→ Sound can be a cue for caution only if it is heard above bg noise and attracts attention.

→ If cue frequency is louder by 10dB from bg noise, it can be sensed easily. Less attenuation is seen in confined spaces.

Auditory Cues include:-

→ Intensity of bg noise at points where the cue is to be heard.

→ Frequency of noise.

→ Attenuation of cue intensity from source.

The cue must also be easily identifiable from other sounds.

c) AUDITORY CUEING IN VISUAL SEARCH :-

→ The use of stereo headsets provides a 3D audio heads up display. Bolia evaluated effects of spatial audio on the performance of pilots searching a complex visual scene with distractors.

→ The auditory cue was presented spatially via a grid of 4 loudspeakers. The intensity of modulation of sound from each produces an auditory image of the target location for which the pilot is searching.

→ Advantages of auditory displays include the fact that they are more alerting, with eyesfree and handsfree options, capturing attention more efficiently. They also helps to communicate with people working in dark places at night.

d) VOICE WARNINGS :-

→ Wolgater and Young investigated behavioural compliance to voice and print warnings. Compliance was greater to voice than to print

→ Voice is attention seeking and omnidirectional and can orient people to hazards such as slippery floors. Voice conveys information directly.

→ Audio warnings are useful when operators have high mental workload. Demand is placed on attentional resources to carry out the task.

→ In situations where we have to perform dual tasks warning intensity is crucial. It is observed that a minimum intensity of 65dB is needed.

c) REPRESENTATIONAL WARNINGS AND DISPLAYS :-

→ They are called earcons, as they are similar to icons. The mapping between an icon and its referent can be symbolic, metaphoric or Nomic.

Design of icons is as follows:

→ Sound must be identifiable.
→ Mapping must be intuitive.
→ Physical parameters should adhere to context.
→ Sound quality must be adequate.

Eg :- Car horn is less ambiguous than sound of skidding.

→ Reaction time to conventional warning is no faster than to no warning at all.

3. DESIGN OF CONTROLS :-

Control dimensions must be determined for appropriate anthropometry. Some of the principles used are the following:-

a) VEHICLE CONTROLS :-

→ The usability of joystick, steering wheels can be affected by resistance to control which should be operable using forces that are a factor of operator's maximum voluntary contraction.

→ With position controls, the displacement of control is a direct relation to the change in controlled part.

→ Some options for control design are control static stick friction, preload, control/display ratio and control system hysteresis.

→ Static friction aids in the presence of vibration. Inertia and viscous dumping can be used for smooth action of controls.

b) CONTROL DISTINCTIVENESS :-

→ Numerous controls are grouped together on a panel and the designer's task is to ensure that operators can easily identify the different controls.

→ Designers may choose from shape, colour, texture, size, operational method. The main tactile cues that may be used to identify controls are texture, size and shape.

→ The selection of the controls provides good tactile cues is particularly important when operators have to work in poor lighting.

c) CONTROL RESISTANCE :-

some of the recommended practices are given below.

→ Most keyboards used with visual display terminals have the letters of the alphabet arranged in QWERTY.

→ QWERTY comes with its own costs: It overworks left hand and some of the fingers and underutilises the home row of keys. Since the arguments in the favour of QWERTY are no longer valid, alternatives have been evaluated.

→ The Dvorak layout places the most common letters in the middle of 3 rows. The training for Dvorak needed 50 hours.

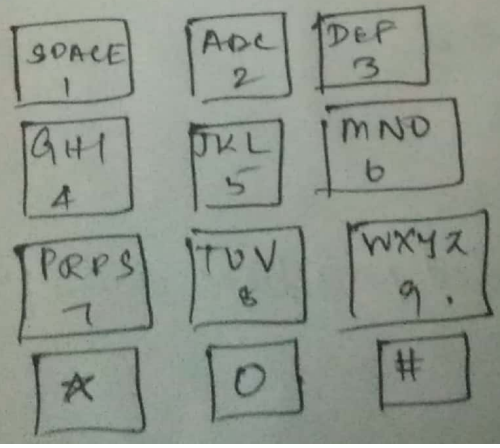
→ The reason why QWERTY was famous because users were a lot familiar with the layout.

→ Modern day keyboards require less force for key activation compared to typewriters.

→ Soft keyboards are seen a lot in electronic devices and can be used using a stylus. Soft keyboards suffer from space limitations. Based on several layouts these are the conclusions.

→ Search times are shorter for familiar layouts.

→ Unfamiliar layouts had longest search times.



d) POINTING DEVICES :-

→ Mouse is the most common pointing device. The ergonomics is at the physical level.

→ Handling the mouse requires addiction of shoulder and increased muscular load.

→ In soft keyboards, pointing is done using touch stimulus.

4. DESIGN OF VIRTUAL ENVIRONMENTS :-

In the process of designing virtual environments these are the techniques followed :-

a) USABILITY FACTORS :-

Functionality - the interface provides the level of control user expects to complete a task.

Natural Inputs - The user's interaction with system.

Help - is available on demand.

Display - for understanding information.

Consistency - Operation is consistent with understanding & convention.

Flexibility - users are not artificially constrained.

Model Fidelity - Task interaction with the model.

Error correction - Errors can be corrected before they become permanent.

Usability - Interaction should be intuitive

sense of immersion - the user becomes part of system.

b) CYBERSICKNESS:

The major ailments associated with Cyber sickness include :-

- Nausea & Vomiting.
- Oculomotor disturbances.
- Disorientation ataxia.

Cybersickness is the cause of discrepancies between optic flow experienced in the VE system, particularly in the haptic feedback. When leaving VE there may be some readaptation to the real world. This suggests that VE introduced some recalibration of the processing of proprioceptive information.

The nausea is due to sensory conflict between visual system feedback and vestibular system. Conflict can occur when the scene changes to indicate movement of user in VE but head remains still.

Vection is another serious cybersickness because of exposure to visual cues in the VE in the absence of any real movement. Vection is the illusion of movement in the opposite direction. To reduce cybersickness one has to minimize the sensory conflict.

b) HEAD MOUNTED DISPLAYS:-

HMD has an adevantage over CRT or fixed panels if the update of the display can be closely synchronized temporally and spatially with the head movements. Disparate views of the VE can be presented.

Light from HMD passes through a lens before reaching eye, so the light rays are parallel as if the displays are at ∞. As a distant object approaches the person the demand for vergence and accomodation increases. It leads to aestheopice in HMD weavers as part of visual aftereffects.

c) HEAD MOUNTED DISPLAYS AND SPACE NAVIGATION :-

HMD offers advantages for 3D Navigation. The head movements that we use for our way in the real world are there in VE & hence mapping between real world & VE tasks would be easier.

Subjects orientation in space is no different, so a cognitive map was developed for space. The use of these devices may impose additional cognitive demands and tax the capacity of those that have low spatial ability.