AR-9233; B.TECH (EIGHTH SEMESTER), 2013

MODEL ANSWERS [SUB: PRODUCT DEVELOPMENT]

SECTION-A

ANS: 1 **Step 3: Sensitivity analysis.** We visualize a system as being described in the form of equations or a mathematical model involving the design parameters and the input and output variables, We would like to know how sensitive the performance of the system is to the adjustment of several design parameters. Those which critically affect the performance must be carefully adjusted, whereas others which are less critical can be adapted to suit convenience. In recent years, Taguchi the Japanese pioneer of quality control, has been advocating the concept of robust design. According to his philosophy, the design parameters which, on changing, result in a large change in undesirable output from the system, should be deleted. Identification of such parameters is possible through factorial design of experiments.

ANS: 2 **Step 4: Compatibility analysis.** A system or a complicated device can be thought of as an object which is itself a combination of objects on the next lower order of complexity. In the case of a complex system such objects would be referred to as sub-systems.

Compatibility may involve straightforward considerations such as geometrical tolerance or chemical tolerance. More difficult problems of compatibility arise when interacting co-members must have matching operating characteristics, as when one member is in series with another so that the outputs of one are the inputs of the other. One example of this aspect of compatibility is electric motor and pump combination.

ANS: 3 Preferred Numbers are defined as "a series of numbers selected to be used for standardization purposes in preference to other numbers. Their use will lead to simplified practice and they should, therefore, be employed whenever possible for individual standard sizes & ratings, & for a series there of. in applications relating to important & characteristic

ANS: 4 linear dimensions, or areas, volumes, weights & capacities

17.5.8 Labeling and Finish Guidelines (AMONG THE FOUR ANY TWO)

1. Ensure compatibility of ink where printing is required on parts to maintain maximum value of recovered material.
2. Eliminate incompatible paints on parts—use label imprints or even inserts. This is because many level-removal operations for paints cause part deterioration.
3. Use unplanted metals that are more recyclable than plated because some plating can eliminate recyclability.
4. Use electronic part documentation because these parts can be reused.

ANS: 5 Types of reactions:

* Attitude (IS the product good/bad?)
* uniqueness / differentiation (How unique is the product?)
* Relevance (How relevant is the product to you?)
* Intention (will you buy the product)

Highlighted points are considered as key words while evaluating.

Ans No: 6 Anthropometry: The starting point of the design of work spaces must be the dimensions of the people who are going to operate within given spaces. Thus one of the primary responsibilities of ergonomics is to provide data about body size. Such a study, which is part of the domain of the anatomist is called Anthropometry

Ans No: 7 **11.6 MAN/MACHINE INFORMATION EXCHANGE**

Refer to Figs. 11.10 and 11.11. The man/machine interface is an imaginary plane across which information is exchanged between the operator and machine. Information is conveyed from the machine to the man by the display elements of the interface, and from the man to machine by the control elements of the interface. The separate problems of displays and control have already been discussed, but there are also the more general aspects of man/machine information exchange.

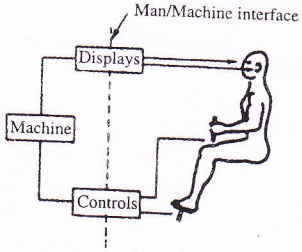


Fig. 11.10 Man/Machine interface.

Ans: 10

(b) **Mock-ups.** This is a proven and old technique in model-making. It involves making a false model to simulate the real product or prototypes. It is made in wood or plaster instead of, say, cast iron or plastics. The mock-up has to be painted in suitable metallic or other paint to create an impression of the actual future product. There is a trend now-a-days of designing for ease of operation, i.e., ergonomic design. The person who is to use the product is looked upon as an object needing space, user of physical effort, sensor or observer and finally, controller of the product. The latest trends in mock-ups simulate human mannequins on the CAD terminal and determine "Space requirement envelope" of the dummy, check up how man and machine fit, and carry out a stress analysis on the dummy, should an accident occur. These methods help build better and user friendly designs through interactive computer graphics and animation. The latest trend in "mock-up" is to use CAD instead of plaster of paris or wood mock-ups (see Chapter 13).

Ans: 08 A procedure for an international registration is offered.. An applicant can file a single international deposit with WIPO.
Design will then be protected in as many member countries of the treaty as the applicant wishes.

Ans: 09 The right to have authorship recognized on the work
The right to integrity of the work, right to object to work being modified.

SECTION-B

UNIT-I

ANS NO: 2

(ix) **Subproblems.** During the process of solution of a design problem, a sublayer of subproblems appears; the solution of the original problem is dependent on the solution of the subproblems. The "Design Tree" of Fig. 1.1 reveals the concept of subproblems.

(x) **Reduction of uncertainty.** Design is derived after processing of information that results in a transition from uncertainty, about the success or failure of a design towards certainty. Each step in design morphology from step (i) to step (x) enhances the level of confidence of the designer.

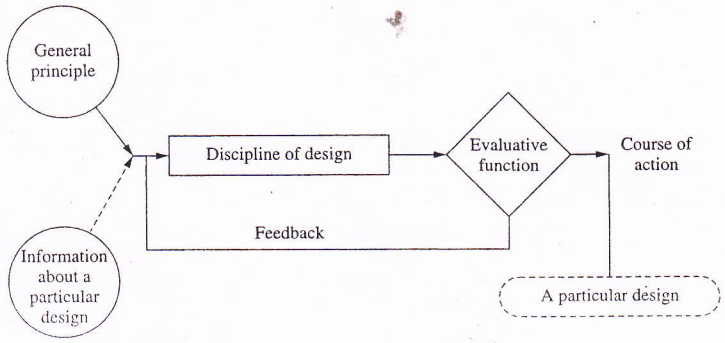


Fig. 1.3 Iterative nature of design process.

(xi) **Economic worth of evidence.** Information gathering and processing have a cost that must be balanced by the worth of the evidence, which affects the success or failure of the design. Authentic information should be gathered to make the design project a success. Today, information is regarded as a resource which is as valuable as money, manpower and material.

(xii) **Bases for decision.** A design project is terminated when it is obvious that its failure calls for its abandonment. It is continued when confidence in an available design solution is high enough to indicate the commitment of resources necessary for the next phase.

(xiii) **Minimum commitment.** In the solution of a design problem at any stage of the process, commitments which will fix future design decisions must not be made beyond what is necessary to execute the immediate solution. This will allow maximum freedom in finding solutions to subproblems at the lower levels of design. A model of design problem, subproblems etc. is developed through a *design tree* (see Fig. 1.1).

(xiv) **Communication.** A design is a description of an object and prescription for its production; it will exist to the extent it is expressed in the available modes of communication. The best way to communicate a design is through drawings, which is the universal language of designers. Three-dimensional renderings or cut-away views help explain the design to the sponsor or user of the design. The present day impact of computer aided modelling and drafting has resulted in very effective communication between the designer and the sponsor.

ANS NO: 03

1.7 THE MORPHOLOGY OF DESIGN (THE SEVEN PHASES)

The morphology of design refers to the study of the chronological structure of design projects. It is defined by the phases (see Fig. 1.2) and their constituent steps. The various steps involved in the design phases will be discussed in detail in the following sections. Of the seven phases, the first three phases belong to design, and the remaining four phases belong to production, distribution, consumption and retirement.

1.7.1 Phase I—Feasibility Study

A design project begins with a feasibility study; the purpose is to achieve a set of useful solutions to the design problem. Sometimes, a design group is assigned a project for which a design concept has already been fixed. This implies one of the three possibilities:

1. A feasibility study has been previously done.
2. The design department has so much experience with the particular design problem that further study is superfluous.
3. The top management, by omitting the feasibility study, is proceeding on unsupported intuition.

The first step in the study is to demonstrate whether the original need, which was presumed to be valid, does indeed have current existence or strong evidence of latent existence. The second step is to explore the design problem generated by the need and to identify its elements such as parameters, constraints, and major design criteria. Third, an effort has to be made to seek a number of feasible solutions to the problem. Fourth, the potentially useful solutions are sorted out from the feasible set in three steps on the basis of physical realizability, economic worthwhileness, and financial

feasibility. Finally, the completed study indicates whether a current or a potential need exists, what the design problem is, and whether useful solutions can be found. It investigates the feasibility of the proposed project. Computer aided modelling is very useful in generating alternative designs from which the best can be selected.

1.7.2 Phase II—Preliminary Design

The preliminary design phase starts with the set of useful solutions which were developed in the feasibility study. The purpose of preliminary design is to establish which of the preferred alternatives is the best design concept. Each of the alternative solutions is subjected to quantitative analysis until evidence suggests either that the particular solution is inferior to some of the others, or that it is superior to all the others. The surviving solution is tentatively accepted for closer examination. Synthesis studies are initiated for establishing to a first approximation the fineness of the range within which the major design parameters of the system must be controlled. Further studies investigate the tolerances in the characteristics of major components and critical materials which will be required to ensure mutual compatibility and proper fit into the system. Other studies examine the extent to which perturbations of environmental or internal forces will affect the stability of the system. Sophisticated methods such as the finite element method are used now-a-days to carry out design analysis of components, with a view to finding critical areas of stress concentration. Photoelastic studies are also of great help in accurate stress analysis.

Next, project type studies are undertaken to know as to how the solution will be feasible in future. The socio-economic conditions, such as consumers' tastes, competitors' offerings or availability of critical raw materials may change; the state of technology may advance and, eventually, corrosion, fatigue, and deterioration of performance may set in. Time will almost certainly erode the quality of the product. The question is: how fast? The rate of obsolescence or wear must be accounted for. The critical aspects of the design must be put to test in order to validate the design concept and to provide essential information for its subsequent phases.

UNIT – II

ANS NO:04

2.5 THE THREE S's

The three S's refer to standardization, simplification, and specialization—three related subjects which are at the root of any economic analysis of product design. The three S's can be defined as follows: *Standardization* is the process of defining and applying the "conditions" necessary to ensure that a given range of requirements can normally be met with a minimum of variety and in a reproducible and economic manner on the basis of the best current techniques. Reduction is the essence of standardization: The effect of variety reduction on production and set-up times is shown in Fig. 2.2. It has attained so much importance that ISO 9000 system of International Standards has now become

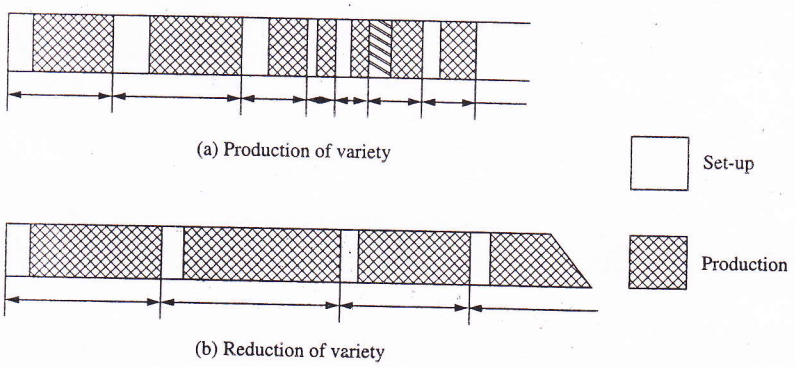


Fig. 2.2 Effect of simplification and variety reduction on set-up and production cycle times.

2.6 STANDARDIZATION

Standardization covers a wide field of activity. These activities include:

1. Physical dimension and tolerances of components within a defined range.
2. Rating of machines or equipment (in units of energy, temperature, current, speed, etc.).
3. Specification of physical and chemical properties of materials.
4. Methods of testing characteristics or performances.
5. Methods of installation to comply with minimum precautionary measures and convenience of use.

PAGE NO: 04

The first three categories relate to limitation of the number of sizes or grades and some aspects of quality, one of the important aims being interchangeability of components or assemblies. Adherence to standards of raw materials is one of the fundamentals of product design since any deviation from the standards in this respect may cause a substantial increase in the cost of materials. Industry is rich with examples in which the designer specifies "special" materials whereas the standard grades can do just as well.

Standardization and interchangeability impose certain limitations on the designer and demand high skill and effort in planning. It is easy enough when designing a new component to decide that no standard really meets the special requirements of the case in hand and that a part has to be specified. What designers seem to forget is that one of the purposes of standards is to provide solutions to relieve them of the task of having to solve afresh some basic problem, and thereby allow them more time to concentrate on the broader aspects of the design.

Another prerequisite of interchangeability is the precision required in the manufacturing process in order to obtain production within the specified tolerances. This implies that production control has to be tightened so that any deviation from the given standards will be immediately noticed and appropriate action can be taken to avoid the process getting out of control.

Ans No: 04 continued.

2.8 SIMPLIFICATION

Simplification is a constant source of disagreement between the marketing department and the production personnel. A production engineer prefers little variety, minimum set-up, and long runs (see Fig. 2.2). Simplification enables the production department to improve planning, achieve higher rates of production and machine utilization, and simplify control procedures. The salesman, on the other hand, strives to satisfy the customer by giving him a choice or by offering him the nearest to what he wants. The pros and cons of simplification are given in the following tabular representation:

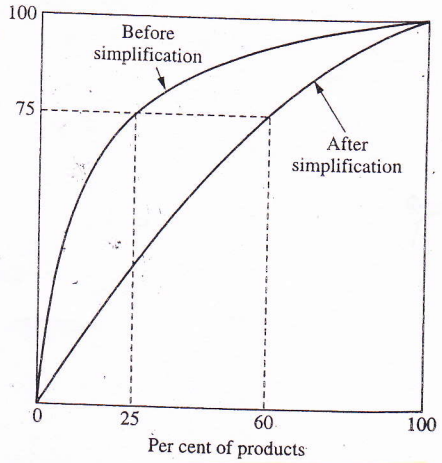
Pro-Simplification	*Pro-Variety*
Reduce inventories of materials and finished products.	Satisfy a wide range of demand.
Reduce investment on plant and equipment.	Enable better contact with the market to study its tastes and requirements.
Save storage space.	Avoid losing orders for more salable products because the customer directs all his orders to other vendors.
Simplify planning and production methods.	
Simplify inspection and control.	Create demand.
Reduce required technical personnel.	
Reduce sales price.	
Shorten or eliminate order queues.	

Perhaps the last point in favour of variety deserves further clarification. Some sales people claim that variety encourages consumption and that, especially where consumer goods are concerned, the psychological effect of plenty creates demand. Further, market research by some firms seems to suggest that in some cases similar products tend to capture roughly the same portion of a given market. The prospects of increasing total demand on the one hand and the firm's portion of the market on the other, may have been the main causes for boosting variety to the extent found nowadays in industry. From the customer's point of view, this is a very unsatisfactory state of affairs. A flood of variety pleases the customer, who ceases in many cases to appreciate the fine distinction between similar products and has either to make a haphazard choice or to invest effort, time and study (and quite often money) to enable him to make an intelligent choice.

This is undesirable for the firm as well. Apart from missing all the advantages listed above, when simplification is applied, an analysis of the market sometimes shows that variety has long exceeded the saturation point and that an increase in variety will not even be noticed in the market.

Also, the division of the market between a large number of products (in fact, too large) makes each portion so small that prices have to be kept at high levels to avoid losses.

When a great variety exists, a sales analysis can be made to establish the salability of the products. When the accumulated sales income is plotted against die number of products offered for sale, it is often revealed that a comparatively small number of products contributes substantially to the total sales (Fig. 2.3). This is sometimes referred to in industry as the "25% to 75%" relationship because in many cases it was found that 25% of the products brought in 75% of the income, although in some extreme cases, studies revealed as small as 10 to 90% relationships. This leads to unnecessary drain of



Page No: 05

Ans No: 5

(i) **Functional aspect.** When the marketing possibilities have been explored, the functional scope of the product has to be carefully analyzed and properly defined. Sometimes, functional aspects are multiple, and usage of the product can be left to the customer's choice. A steam iron is a case in point. The additional function of dampening the cloth when required, prior to or during ironing, is incorporated in the steam iron, the main functions of which is to iron the cloth. The customer can decide whether and when to exploit this characteristic of the apparatus.

There is a trend to offer functional versatility of the product, thereby increasing the range of applications and sometimes combining several tools in one. A mixer, for example, allows for a large number of attachments to be added for a variety of duties. It is labelled as a "kitchen machine" to enhance its positioning. Basically, the mixer housing contains a power unit and a speed regulator, but it has to be so designed as to serve all the attachments, and the customer has to decide and define for himself the functional scope to be compatible with his needs, his taste and his pocket. Again, household power-tool sets are designed on very much the same principle: The hand drill such as Wolf Cubmaster is the basic unit, and with attachments it can become a table drill, a lathe, a grinder, etc. Versatility of production machinery may quite often result in substantial savings in production shopfloor space and

(ii) **Aesthetic aspect.** In what way does the appearance of a product affect its design? In most cases where the functional scope, durability and dependability have already been defined, the aesthetics aspect is mainly concerned with moulding the final shape around the basic skeleton. This moulding of shape may very often be severely limited in scope, and what finally emerges is sometimes termed a *junctional shape*. The view that functional shape is necessarily divorced from aesthetics is well illustrated by bridges, locomotives, or machines of the late 19th or early 20th century.

1. *Use of special materials, either for the parts of the housing or as additional decorations.* Notable is the use of chromium strips, plastics, wood, glass and fabrics for the purpose.
2. *Use of colour, either natural colour of the material or colour provided by paints, platings, spraying, or even lighting.* Composition and contrast of colours is of great importance to the industrial designer in creating a design with convenient operational and aesthetic characteristics.
3. *Texture supplements colour, either by appropriate treatment of the given surfaces or coatings.* Surface finish and requirements of brightness as determined by styling may in turn affect the production processes in the finishing stages. Matt finish, mirror finish, and mottled finish are examples of surface finish varieties which are in vogue.
4. *Shape denoted by outer contours and similarity to familiar objects.* Shape can be exploited to accentuate particular features, to create a sense of spaciousness or illusions of size, richness and dependability.
5. *Use of line to break the form.* It is also used for the purpose of emphasizing parts of it, or to give a sense of continuity, graciousness and attainability.
6. *Scaling the product, either to a blown-up size or to a small size* (modelling). This creates novelty and a sense of completeness. The success of styling of some popular small automobiles in Europe may be partly due to the designer's talent in creating a feeling of stillness having the full-size version, with all its features.
7. *Packaging, especially for small items, novelty and attractiveness of packaging are often transferred in the mind of the customer.* In extreme cases packaging may assume an appreciable portion of the total production costs and become the centre of the design project.

UNIT – III

ANS NO: 06

17.5.2 Material Selection Guidelines (G.E.)

1. Avoid regulated and restricted materials because they are high impact.
2. Minimize the number of different types of material. This simplifies the recycling process.
3. For attached parts, standardize on the same or a compatible material. Eliminate incompatible materials. This reduces the need for disassembly and sorting.
4. Mark the material on all parts. The value of many materials is increased by accurate identification and sorting.
5. Use recycled materials to stimulate the market for the material that has been recycled.
6. Use materials that can be recycled, typically ones as pure as possible (no additives). This minimizes waste; increase the end-of-life value of the product.
7. Avoid composite materials. Because composites are inherently not pure materials, and so not amenable to recycling.
8. Use high strength-to-weight materials on moving parts to reduce moving mass and therefore energy consumption.

ANS NO: 07

~~and reactive.~~ Sources that rely on active efforts of the company utilize many aspects of the situation analysis:

1. *Customer analysis,* in particular usage/needs analyses and surveys of attitudes and attribute importance, including both unstructured (e.g., focus groups) and structured (e.g., conjoint analysis) approaches. Also, many companies maintain facilities where customers are less obtrusively observed using company products or product mock-ups (e.g., Sony on Michigan Avenue in Chicago, Whirlpool at its headquarters).
2. *Competitor analysis,* specifically studying what competitors sell or are working on. Most new products are copies of competitors' products (e.g., RC Cola first introduced diet cola).
3. *Active search,* particularly of new products and processes in other areas with an eye toward incorporating them in the company's own product.
4. *Category analysis,* examining changing social trends and technologies (often through various media and trade associations).
5. *Brainstorming.* Generating ideas for new products can be difficult. For that reason, a number of structured procedures have been generated such as Tauber's (1972) HIT method, the noun-verb word-pair approach of Durge, O'Connor, and Veryzer (1996), and so-called creativity templates (Goldenberg, Mazursky, and Solomon, 1999). A variation on this is what we call "grammatical tinkering." This approach first requires a detailed description of a current product in terms of current customers (who, what, how, why, etc.), ~~pricing, and advertised use).~~ Once constructed, creativity simply consists of breaking these "rules," first one at a time and then in combination. This approach generates multiple types of new products such as the following:

New market/customer acquisition: Who else can we sell it to?

Customer expansion: What else can we sell them?

Product variants and line extensions: What different features can we add, replace, or displace?

Value chain changes: How else can we get it to the customer?

Brand extensions: What other products have brand equity (e.g., high-tech) and attributes (e.g., microprocessors) similar to our current product?

UNIT – IV

ANS NO: 08

Defn of Anthropometry Refer Ans: 06 (short answer type).

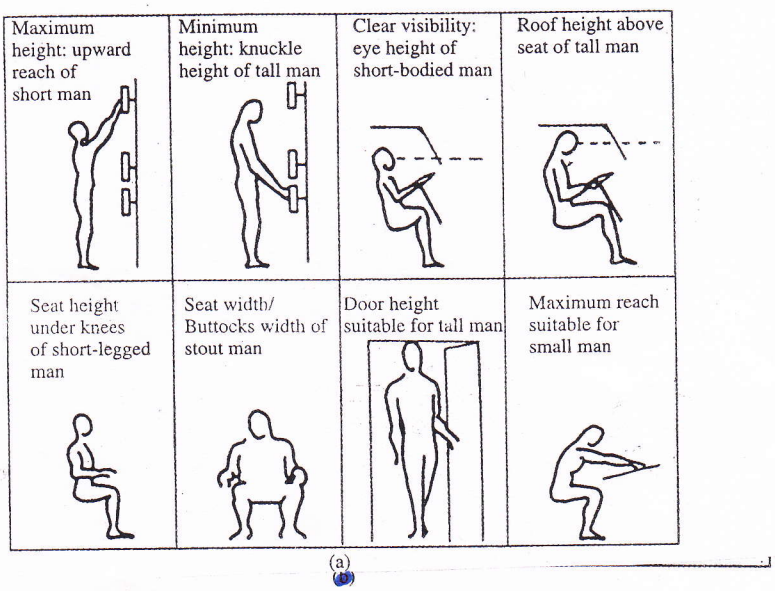
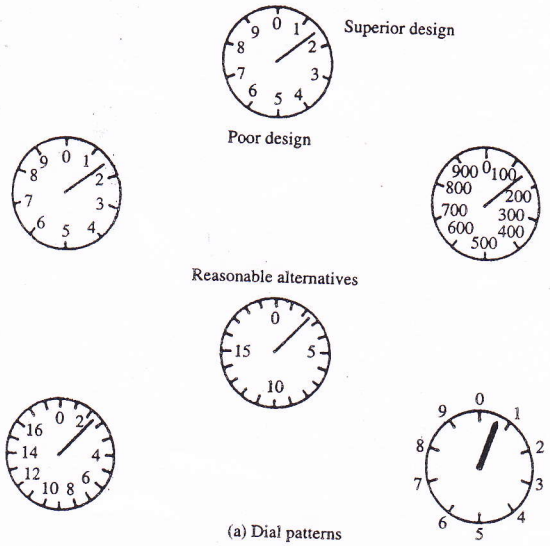


Fig. 11.4 (a) Importance of range of body size in design. (b) Postural aspects of seating.

ANS NO: 09 ~~11.6~~ **THE DESIGN OF DISPLAYS**

Refer to Figs. 11.8 and 11.9. A display is a part of the environment of the operator that provides him with information relevant to the task he is performing. Common examples of display are: (a) display on a TV screen, (b) dial type display with pointer, and (c) simple mechanical display, e.g an advertisement card on a visiting card.



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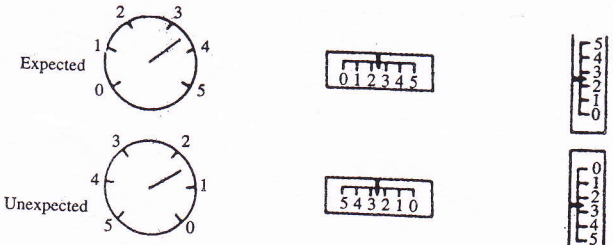

(b) Display stereotypes

Fig. 11.9 Design of display.

Various types of display

(i) **Pictorial display.** This consists of some level of direct representation of the real situation, for example, a spot moving across a map representing position, or a tiny model aircraft and an associated line, with the model and line moving in synchronization with the real aircraft and the horizon.

(ii) **Qualitative display.** This indicates a general situation, rather than a numerical description of it. This is often quite adequate for the needs of the operator. For example, a light showing whe the oil pressure is too low is satisfactory for most car drivers, rather than a gauge that indicates the pressure in units.

(iii) **Quantitative display.** This presents a number denoting the value of some variable in the situation. There are two main types—the moving-pointer fixed scale display and the digital display. The fixed-pointer moving scale display—a hybrid of the two—is not commonly used, because of the confusing nature of the relationship between the scale direction, the scale movement and the pointer. Design guidelines of markers, distance between markers, graphics and visual communication are important areas of product design, recommended by Woodson and Conover. The height of the letter, h (mm) and the width of the letter, w (mm) can be expressed as a function of viewing distance s in metres.

$$W_{mrn} = 0.15 \text{ mm}$$

Table 11.2 Letter size as function of viewing distance

Class	h	w
Major index	$8s$	$1.5s$
Intermediate index	$6s$	$1.2s$
Minimum index	$4s$	$1s$

This last point is one aspect of the more general problem of population stereotypes, already mentioned in relation to controls. For displays, the expected patterns in Europe and USA are that scales should increase from down to up, from left to right and clockwise.

There are only three important channels through which the operator receives information—the eyes, the ears, and the sense of force and motion, or, to use more scientific terminology, the visual, the auditory and the kinesthetic sensory channels. The task of the ergonomist is to allocate the required information between these channels, according to their relative advantages and disadvantages and to ensure that, for each channel, the signals are above the threshold value.

UNIT - V

10 Ans: under economic rights, the creators of a work can use their work as they see fit. They can also authorize or prohibit the following acts - in relation to a work

Reproduction: in various forms, for ex in a printed publication or by recording the work on cassettes, compact disks, or video discs, or by storing it in computer memories

Distribution: for example through sale to the public of copies of the work

Public performance: for example by performing music during a concert, or a play on stage.

Broad casting & communication to the public: by radio or T.V, cable or satellite

Translation into other languages

Adaptation, for example by converting a novel or a play into a screen play for a film.

11 Ans:

An industrial design is the ornamental or aesthetic aspect of an article. The design may consist of 3-dimensional features such as shape of an article, or 2-d features such as patterns, lines or color.

contd:-

Industrial designs are applied to a wide variety of products of industry and handicrafts such as technical & medical instruments, watches, jewelry, housewares, electrical appliances, vehicles, architectural structures, textile designs, leisure goods and other luxury items.

To be protected under most national laws, an ID must appeal to the eye.

This means that an industrial design is primarily of an aesthetic nature, & does not protect any technical features of the article to which it is applied.

Protecting an Industrial design:

* helps to ensure a fair ROI
* Improves the competitiveness of a business against copying & imitating the designs by competitors
* Helps to increase the commercial value of a company, as successful industrial designs constitute business assets
* Encourages creativity in the industrial & mfg sectors, as well as in traditional arts & crafts.