UNIT 3
ELEMENTS OF DESIGN PROCESS

Structure

3.1 INTRODUCTION

The architectural design is a problem-solving activity. All designs such as architecture that deal with functional aspects has to solve two kinds of problems; one that deals with how the building will work and cater to the use for which it is designed, and the other, which deals with aesthetic aspect, i.e. how the building will look. This problem-solving activity has a process, sequence and methodology. This unit introduces you to the various aspects of architectural design as a problem-solving activity.

3.2 OBJECTIVES

After studying this unit, you should be able to:

- describe the built environment - their functions and requirements,
- understand the concept of anthropometry -the science of the measurement
- where human being is the yardstick,
- outline the spatial requirements for various activities for which a building is designed, and
- discuss process or sequential stages that leads to a good architectural design.

3.3 DESIGN - A PROBLEM SOLVING PROCESS -TYPES OF BUILT ENVIRONMENT

Let us begin with understanding that architecture deals with built environments and that there are several types of built environments. To begin with, there are houses in which we live which are also of man) kinds and categories. Houses essentially cater to satisfy a basic human need for shelter. There are many people in this world who build their own houses with whatever materials and means they can afford. There are no architects, engineers, contractors involved. There are many examples all over the world where beautiful buildings are built this way. Then, there are houses that are designed to suite the requirements of a client, taking into considerations the site conditions and the economic constraints. There are also many houses and apartments that are being designed and built without any specific user *or* client in mind but only as an answer to the demand for housing in a given society and the affordability of a particular type of housing. Apart from various types of residential buildings, we have factories and industrial complexes, schools, colleges and universities, hospitals, offices and so on. Even though these built environments are so different from each other, there is something common to them all. For example, all these buildings have a function to serve, or rather a set of functions, for which they are built, the function change from one type of building to another. Every building is an enclosure or an envelope which contains spaces within it. This enclosure is usually made up of walls, roof and floor. Different functions require different types of enclosure. For example, classroom or living rooms in a house must have enough windows on the walls to allow good ventilation and light. A factory on the other hand must have provision for north lighting on the roof. A cold storage must be well insulated from all sides. A cinema hall has to be so made that the inside can be made totally dark. A badminton hall should have special wooden flooring. The way in which the enclosure is made, it defines the external form or the external appearance of the building. It is therefore, generally possible, by looking at the building from the outside, to tell whether it is a block of flats or a cinema hall or air terminal or an office building.

The enclosure is made up of different materials. This also gives different character to different buildings. You have seen buildings made of brick and concrete, factories made out of steel, asbestos sheets and glass, huts made of mud wall thatched roof and temples made of marble and so on. They all look different. Different buildings use different structural systems which in turn give different looks to their external forms. Same buildings have flat roofs some inclined. Some would have a large dome or a shell structure or a folded plate.

Check your Progress-I

1. What are different types of built environment?

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2. What is an enclosure and what is it made up of?

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3.4 INTRODUCTIONTO -MAN AS A MEASUREOF EVERYTHING

We normally measure length in meters and centimeters or feet and inches. But these measurements were not always there. Way back in history, man must have measured things with his own hands, fingers, foot etc. Since human measures vary from person to person it was necessary to standardize the measurements in some way, so that when one person says a room is this much long or this much high, it may be clearly understood by the other person. This requires a commonly accepted standard unit of measure and its sub-divisions.

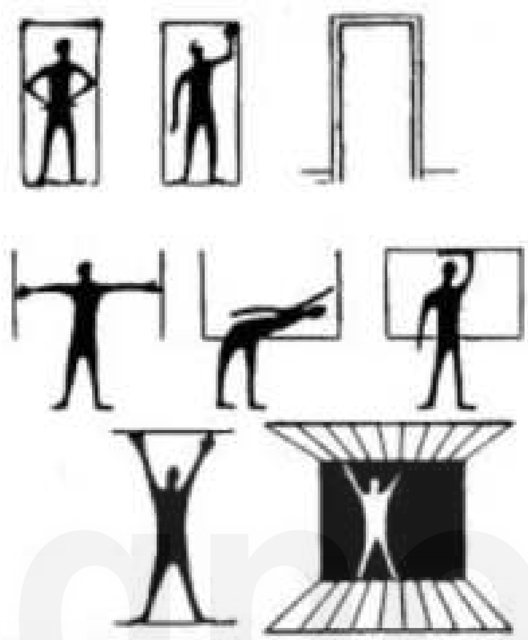

Figure 3.1: Building Components in Relation to Human Measurements

Buildings have various components and they all have sizes and dimensions. Most of the buildings are built for people to use; it makes sense to have a system of measurements that relates to the people who would use the Buildings. The sizes of doors, windows, rooms, passages, and stairs are related to human dimensions and proportions both physically and visually. In the older times, man was considered as the measure of all things. In classical periods like Greek, Renaissance and Indian Architecture, man's proportions were used to determine the dimensions and aesthetic proportions for various types of buildings and various parts of the buildings.

Thus, human measurements (dimensions) or rather the measurements of various parts of the human body (Figure 3.2) and whole become very important for designing buildings.

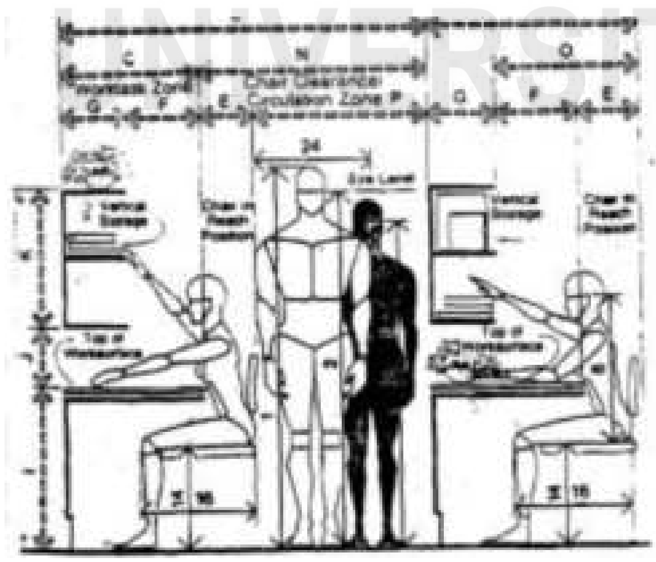

Figure 3.2: Anthropometric Measurement

The science of human measurements is called Anthropometry; Anthropometric data is vital for the design of all man-related objects. It is important to understand that the stature of an American and an Indian are quite different. Also there is a difference between the structures of an average man and an average woman. Anthropometric data of various countries are available in detailed form. While designing a building or a part of a building or a piece of furniture like table or chair, one has to choose the relevant anthropometric measurement. Some books are available containing various 'standard' dimensions and sizes for ready reference. Such standards, if they have to be referred in Indian context, one must make appropriate proportionate adjustments. Indian anthropometric data for different age groups (adults and children) is also being compiled. Even in a specific group, the sizes may vary so much that 'averages' are not always meaningful and sufficient. One has to interpret the data in accordance with the actual physical condition in which it is to be used in design.

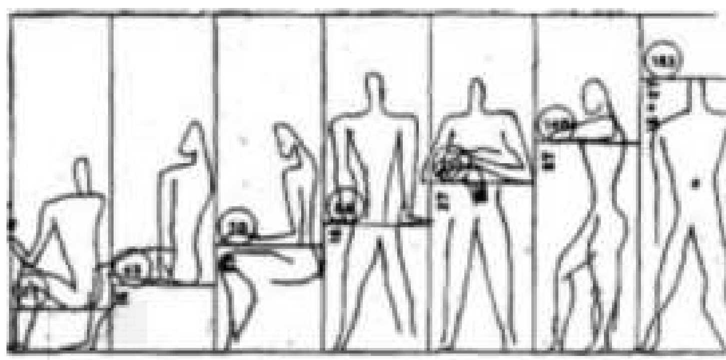

Figure 3.3: Functional (Dynamic) Dimensions (Modular-Corbusier)

Human body dimensions which concern architects are of two types- structural and functional. Structural dimensions generally refer to 'static' dimensions' such as measurements of head, torso, and limbs in standard positions. Functional dimensions, also referred to as 'dynamic' dimensions, include measurements taken in working position or during the movement associated with some task. In course of anatomical studies, almost a thousand different body measurements are possible. But there are some of them which are useful to architects and interior designers as shown in Figure 3.3.

The fascination of philosophers, artists, theoreticians and architects with the human body size dates back to centuries. It was understood that the human body is so designed by nature that the face from the chin to top of the forehead is about one eighth of the whole height; the open hand from wrist to the top of the middle finger is just the same. The foot is about one sixth of the height. The other members of the body and their parts also have their own proportions to each other. Painters and sculpture often used these proportions to achieve good aesthetic results in their work. The naval is the centre in the human body. If a man is placed flat on his back with hands and feet extended, a circle can be drawn with the naval as the center, which will touch the finger tips and the toes. Also, a square can be drawn using height and the arms stretched out on sides as shown in Figure 3.4.

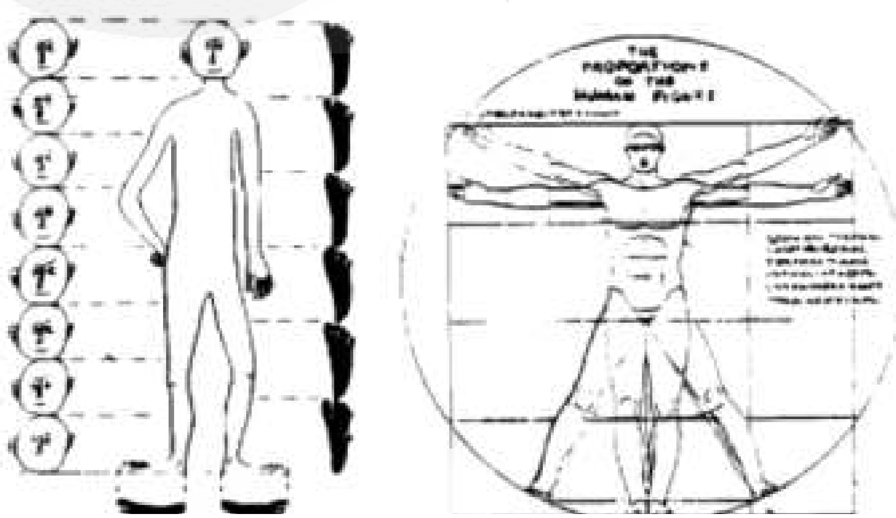

Figure 3.4: Proportions in Human Figure

The Greeks refined these proportions to mathematical and aesthetic perfection. Euclid in 300 BC Greece, evolved 'extreme and mean ratio'. According to him a line is cut in such a way that the ratio of whole to the larger segments is same as the large segment to the smaller segment. In the 19th century this proportion system came to be called the golden section and is far superior to the other proportion systems, and has been employed as a conscious element in architectural design in different ages. In 1948, Le Corbusier wrote a book dealing with this proportion system and its relevance in modem architecture.

He explained in the beginning of his book *'Modulor'* that this may not automatically create good design but it would make bad design more difficult. The most fascinating observation about the Golden Section involves the human figure.

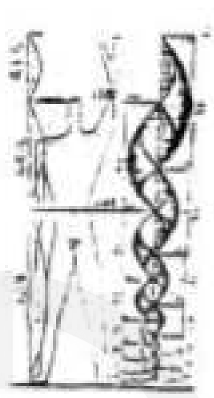

Figure 3.5(a): Le Corbusier's Modulor

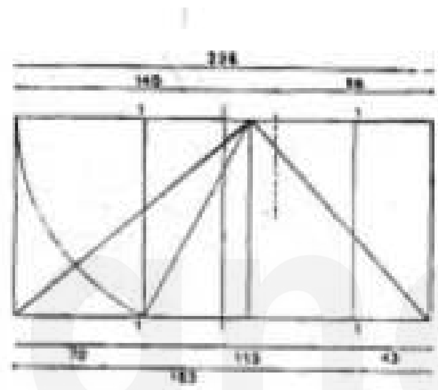

Figure 3.5(b): Golden Ratio Dimensions

The three body dimensions as shown in Figure 5.5 conform very closely to the proportion of Euclid's extreme and mean ratio. In last 3-4 decades, concern for human dimensions and body size, as critical factor in design process has steadily increased. This concern is most in the field of 'Human Factors Engineering' or 'Ergonomics'. This is an inter-disciplinary science which studies the relationship between people and their environments.

Thus, we see that taking human measurements into account we cannot only design buildings which will be suitable for human use but also pleasing to look at. Due to large variation in individual body size, averages are obviously not of much use to a designer. Instead it is necessary to deal with a range. Statistically it has been shown that human body measurements in any given population will be distributed so that they fall somewhere in the middle, with a small number of extreme measurements falling at either of the ends of the spectrum. Since it is not practically possible to design for the entire population, it is necessary to select a segment from the middle portion. Generally, the extremes at both the ends are omitted and 90% of the population is dealt with. Most anthropometric data is generally expressed in terms of percentiles. The total population is divided into 100 percentage categories ranked from least to greatest with respect to some specific type of body measurement. The 5th percentile of stature or height, for example indicates that 95% of the study population will have heights greater than that. Similarly, 95th percentile height would indicate that only 5% of study population would have heights greater and 95% will have same or lesser heights. Percentiles, therefore, indicate the percentage of person within the population who has a body dimension of a certain size or less. Due to many variables involved, it is necessary that the data selected be appropriate to the user of the space or furniture to be designed. It is necessary to identify the intended user in terms of factors such as age, sex, occupation, ethnicity etc. If the user is an individual or a very small group, it may be possible to develop your own anthropometric data by actually taking measurements.

All anthropometric data is measurements taken in a static state. A human being by nature is dynamic. Therefore, while applying the anthropometric data, a designer has to make necessary modifications to incorporate the actual dynamic user condition.

Check your Progress-II

1. What is the relationship of human body dimension to building dimensions?

2. What is Anthropometry?

3. What are the two types of human dimensions?

4. How are aesthetic visual proportions evolved out of human dimensions?

3.5 ACTIVITIES AND THEIR SPATIAL REQUIREMENTS

Any activity whether it is cooking, sleeping, toilet or worship, requires space for its performance. The size of a building will depend upon the space it provides for various activities inside. In order to design a building, it is necessary to have a list of all the activities, major and supporting, and the area and volume required for each one of them. We have seen in the previous section that since most of the buildings are related to human activities, human measurements are the measures of the space required for the activities. Here, as we have mentioned earlier, one has to consider that space requirements may be slightly larger than the static body dimensions. This would also take into consideration the various movements and postures that constitute the activity. For example, the height of a person may be 170 cm tall and 50 cm broad from shoulder to shoulder, but in order to sleep, the bed has to be more than 170 cm x 50 cm. If we take into account the various postures during sleep, the bed may easily turn out to be 200 cm x 90 cm. Two beds in a room will therefore require 200 cm x 180 cm. Around 75 cm to 90 cm space is required at least on three sides of the bed. Then, with a couple of cupboards 90 cm x 50 cm each, a dressing table and a study table, the reasonable size of a bedroom turns out to be approximately 450 cm x 300 cm, i.e. 13.5 sq. m. In this way, it is possible to work out space requirements for various activities if you understand how that activity takes place.

Types of Spaces

As mentioned earlier, there are various kinds of activity-related spaces in a building.
They may be put into following three broad categories:

a. Primary function spaces,
b. Supporting function spaces, and
c. Connecting or link spaces.

In a house, for example, living room, bedroom, kitchen etc. may be termed as primary spaces, store room, balcony, pantry etc. as supporting space and corridors, entrance lobby, staircase etc. as link spaces between other activity-spaces. There are again indoor space and outdoor spaces. Outdoor spaces again may be link spaces such as roads, front porch, etc. or primary function spaces such as garden etc. and supporung spaces like bus stops, parking spaces etc.

In order to evaluate the spatial requirements of an activity one has to take into account three basic components, namely

i. the basic activity for which the space is being designed,
ii. the circulation space that is required around this activity in order that it can happen, and
iii. space required for storage or services which are required to support the activity

In the previously given example of a bedroom for instance, the area of bed is basic activity space, the cupboards, etc. support activity space and movement area in the room is circulation space. Every activity-space may have these three-components but in varying proportions. The ratio between these three components will be different for bedroom, kitchen, toilet, office, auditorium etc. Architects deal with buildings of different types; therefore, different types of activity-spaces have to be dealt with. In order to help the architects and to quantify these spatial requirements, some reference books are available such as ***Architectural Graphic Standards*** or ***Time Saver Standard*** in which various spatial layouts are given for different activities. Figure 3.6 gives an idea of activity-spaces inside a building. These layouts and sizes can only be taken as guidelines and references and not as final design.

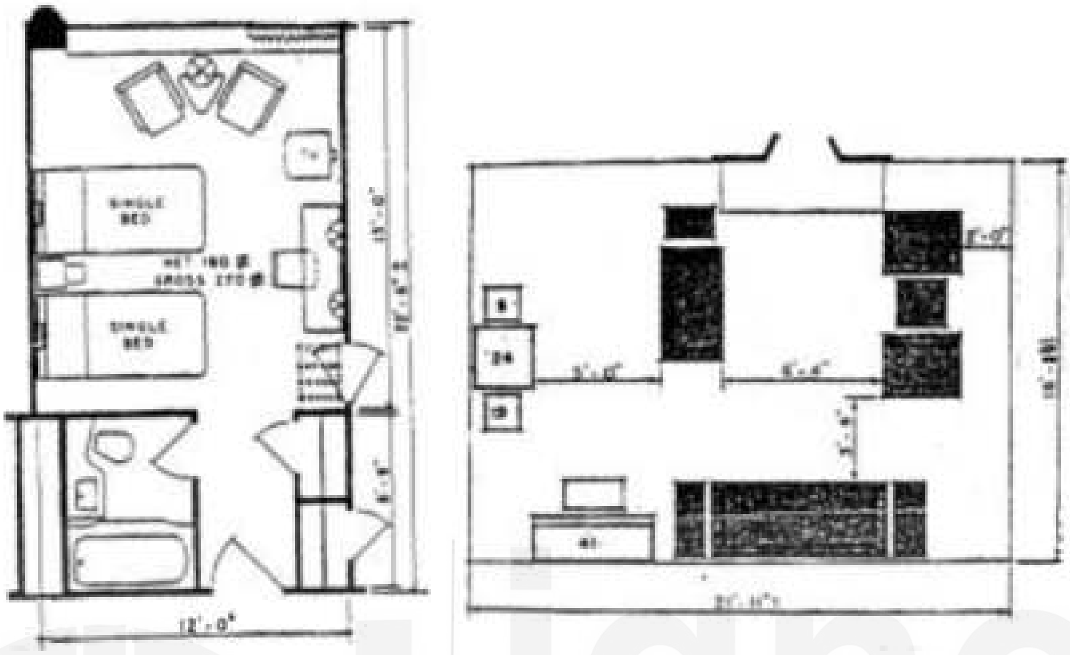

Figure 3.6: Activity Space inside a Building

So far, we have dealt with space in two-dimensional horizontal plane; mainly to understand the foot print of activity in plan. However, space is a three-dimensional entity. We have seen that different rooms have different heights. A toilet has lesser height because the toilet above has a sunk slab, a kitchen or a part of kitchen may have lesser height to make room for a loft. Halls where many people gather usually has more height than a living room in a house.

We have seen that the heights of our rooms are governed by the presence of a fan which has to be at a safe height, but the heights of air conditioned rooms are kept optimum not only because the ceiling fan is absent but because the cooling volume is kept minimum for efficient working of the air conditioner.

Apart from satisfying the functional requirements of an activity, space has also something to do with how you feel in it. You may have noticed sometimes that a room with less height feels crammed whereas a greater height gives a feeling of spaciousness. This is the psychological dimension of space. Size of a space has something to do with how we feel being in it.

Check your Progress-III

1. What are the three main types of activity related spaces in a building?

3.6 SEQUENCE/PROCESS OF DESIGN

We have already discussed that design is a problem-solving activity. Architectural design even though creative and artistic, cannot be considered self-contained and mysteriously evolved. There is indeed a process by which we all think and this process helps us to solve problems.

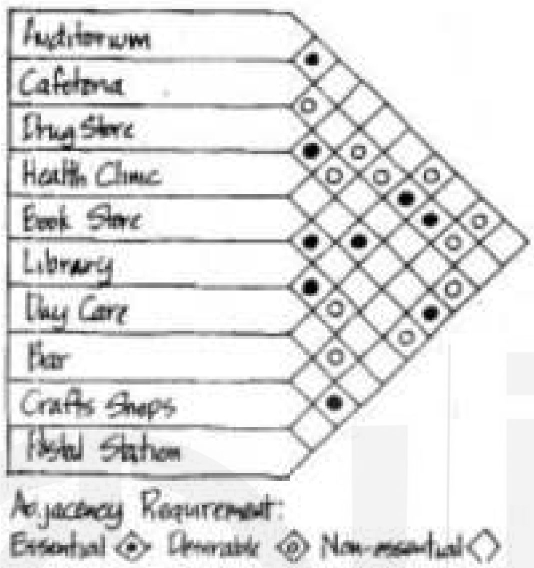

Figure 3.7: Programme Analysis Matrix For a Community Centre

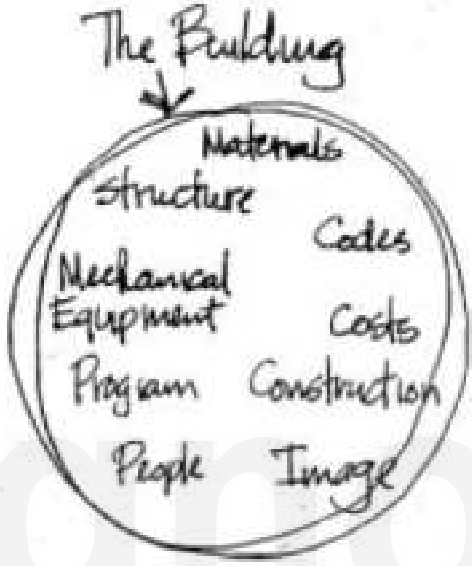

Figure 3.8: The Building- A List of Problems

At the very beginning is the problem, which needs to be stated, defined, understood. Problem in this case is to design a building which will satisfactorily contain several functions. For example, if it is a house it will have a living room, a dining room, one or two bedrooms, a toilet, a kitchen etc. It should also have proper light and ventilation. It should have proper connection with the road and surroundings. It should be firmly constructed with durable materials, it should be easy to maintain and finally it should be good to look at. All these are problems that need to be solved. The list of problems for a school building will be quite different.

W Sat an architect has to do in the beginning is to make a comprehensive list of the problems to be solved. The client will give his requirements, his budget, his site and a few other things. The first set of problem solving may begin with these. The starting point for an architect is therefore a 'building program'. A building program not only lists all the requirements of the building but also quantifies them. Most often clients give their requirements but are not able to quantify them. It is, therefore, the task of an architect to take the list of requirements from the client, add or subtract a few things while discussing with the client, assign sizes (areas) to each of these, work out the total size in terms of art a, volume, floors etc. to take care of clients' requirements and check if the plot and budget assigned for it will be adequate. The list of requirements is often revised to suite site and budget.

The next step is a very important one in architect's work. This is where he studies the list of requirements or the building program and begins to make sketches. This act of sketching is actually a process of converting the requirements into some abstract diagrams which are conceptual ideas about how he perceives the problem. In this process something that is on paper is first perceived by the designer, he then forms a mental image out of this and draws a new image on paper. This cycle may go on several times. At the end of this process an architect arrives at a few conceptual solutions to the problem as he sees it. Having arrived at an abstract conceptual diagram of problem, the next stage is to manipulate and extend it to include the relationships, additional supporting information and alternative configurations of the relationships between various components.

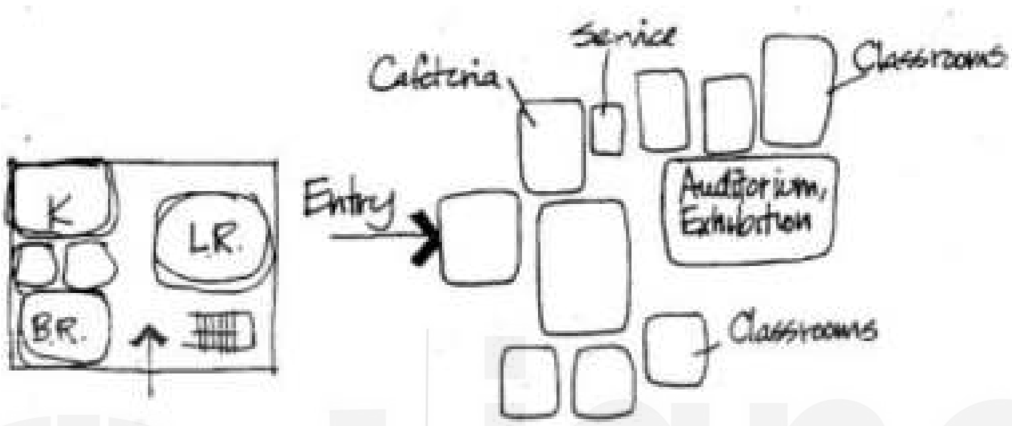

Figure 3.9: Preliminary Sketches

One of the simplest and most commonly used device used by the architects at this initial stage of abstraction is the bubble diagram. Bubble diagram helps designers in many ways. They may be used as models of physical space, program requirements or existing conditions. The main use of this is in representing relationships between various components in plan. Different bubble diagrams may represent different relationship possibilities. This device is most commonly used in building industry.

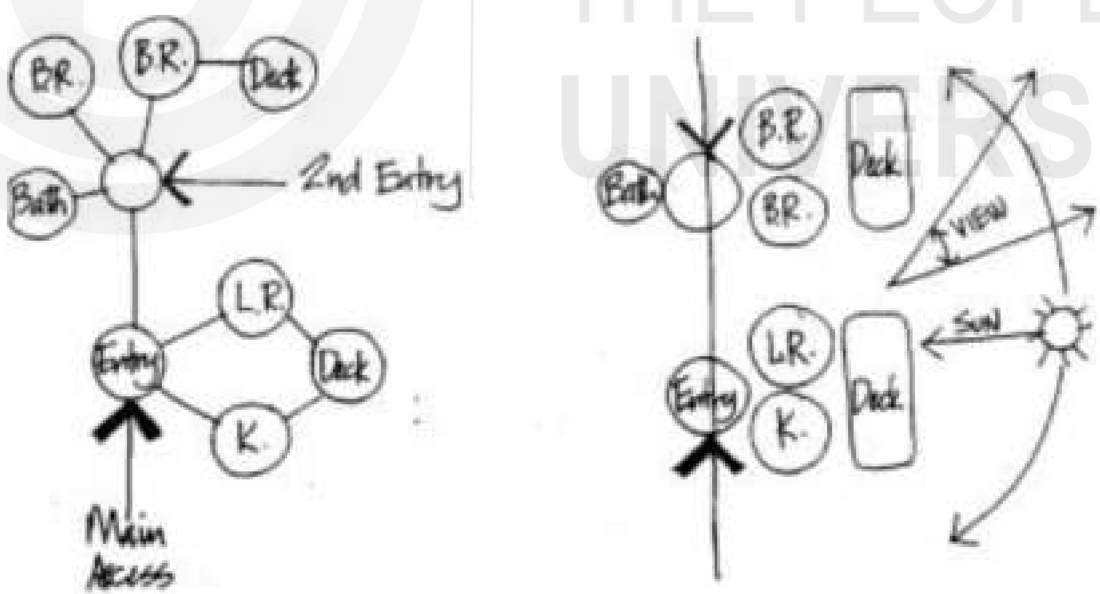

Figure 3.10 (a) 3.10 (b): Bubble Diagram

The initial bubble diagrams developed by an architect are generally processed to building drawings in order to make them understandable to public or client [Figure 3.10 (a), (b) (c) and (d)]. Figure

3.10 (a) represents the abstract diagram and in Figure 5.10 (b) the position of different rooms is established by taking into consideration other parameters such as site orientation, view, access etc. Figure 5.10 (c) takes into account the size and shape of the rooms, layouts in the rooms and the types of spatial experience. Some notion of scale is also introduced at this stage. Figure 5.10 (d) shows the final stage which tightens the plan by taking into consideration some structural system and type of enclosure. At this stage, one is ready to prepare hardline drawings. Various details and sections can also be considered. This way a bubble diagram has been converted from general to particular.

At this stage, design priorities and the hierarchy of spaces is also set. Design decisions based on the budget of building as well as the overall desirable look of the building with respect to proper relationships are broadly taken at this stage.

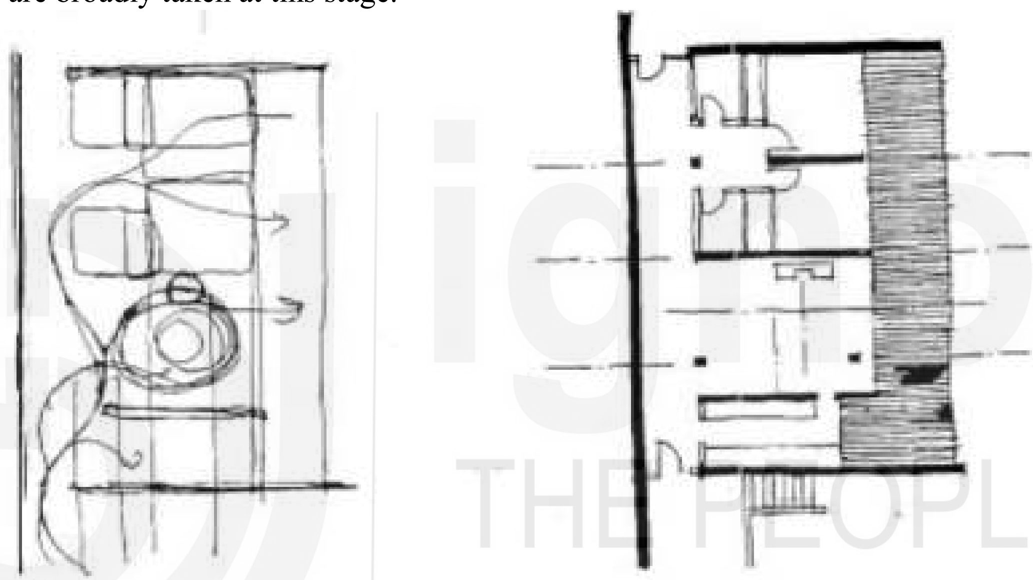

Figure 3.10 (c) and (d): Preliminary Sketch Diagram

The site conditions are also taken into consideration at this state so as to place each room in desirable positions with respect to wind, sun and view. With the above considerations several alternatives are prepared and evaluated.

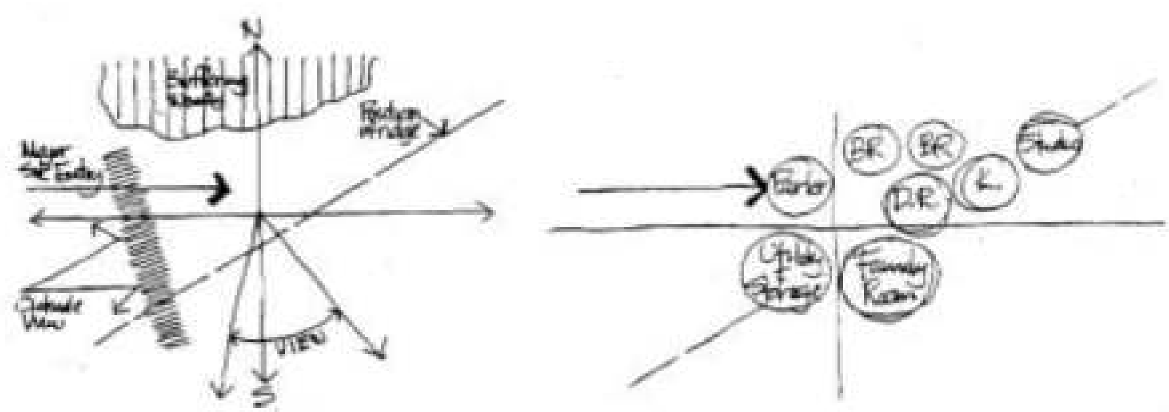

Figure 3.11: Orientation with respect to Site Condition

You have seen in the earlier section that the different main activity spaces are connected with link elements or link spaces. So while making bubble diagram, architect takes into consideration the link elements as well as the intensity of relationship between elements and shows them on the bubble diagram by changing thickness of lines connecting the bubbles.

While generating concepts one goes from an abstract idea to some idea of plan and form of a building. Now the architect is ready with some alternative solutions to discuss with the client. Apart from the functional aspects the client would also like to know at this stage how his building might look. For this purpose, the architect often makes perspective drawings or models to create a simulation of the building that will be constructed.

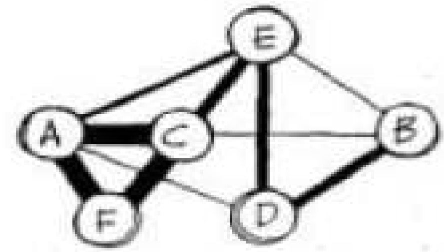

Figure 3.12: Link Elements

The alternative design solutions are then evaluated and compared to arrive at the best and the most feasible solution taking into consideration the site conditions, means of construction and the cost implications.

The next important stage for the architect is to convert his design into reality. For this purpose, detailed working drawings and bills of quantities are prepared which correctly convey the design to the contractors who would execute the building.

This in nutshell is the sequence and process of design that an architect generally follows in order to design a building which, when built, will not only satisfy the functional requirements of the client but also make him feel happy and proud of having constructed a beautiful building. There are many other activities which the architect has to perform after completing the working drawings until the building is completed.

We have seen here that an architect goes through a rigorous process of creative problem-solving to design a good building which satisfies the functional requirements as well as is aesthetically pleasing. You may however keep in mind that the process explained above is not a standard blueprint of procedure followed by all architects. While most architects follow the above mentioned process and sequence broadly, there are variation in working details which depend upon the temperament, the working style, the practical experience and preferences of different professionals.

Check your Progress-IV

1. What are the main stages in the development of design by an architect?

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2. What is a bubble diagram?

3. What is the difference between concept diagram and working diagram?

3.7 SUMMARY

We have seen in this unit that there are various types of built environments. Different types of buildings are built for different purpose/functions. Buildings look different in form as different types of structural systems are used.

Human body dimensions and the dimensions related to different posture of body are important for evolving proper sizes for various components of a building. Different parts of a building should have such dimensions that have a proportional relationship. These proportions can be derived from human body dimension proportions in order to make building look good.

All spaces in a building are related to the size of activity it holds. Size and disposition of space in a building must not only satisfy functional requirements but also psychological needs.

Design is a problem-solving activity. From statement of problem to the final architectural design solution one goes through a sequence or process. A design problem has more than one solution. Design solutions do not only solve functional problems but also attempt to solve aesthetic, symbolic, emotional and other problems as well. In fact, it is nothing but a creative problem-solving.