STRENGTH IN FORMS

(Exploration & Analysis)

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Tamhane 23/7/87
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Signature for approval

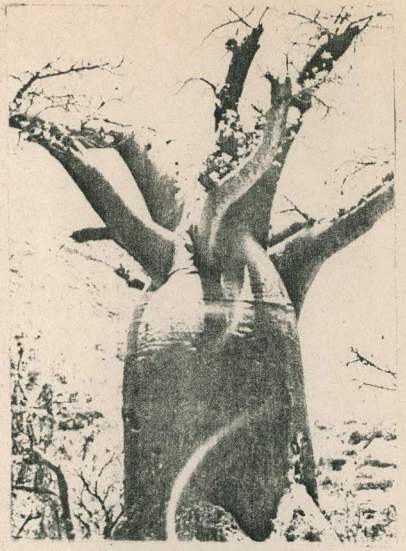
Introduction

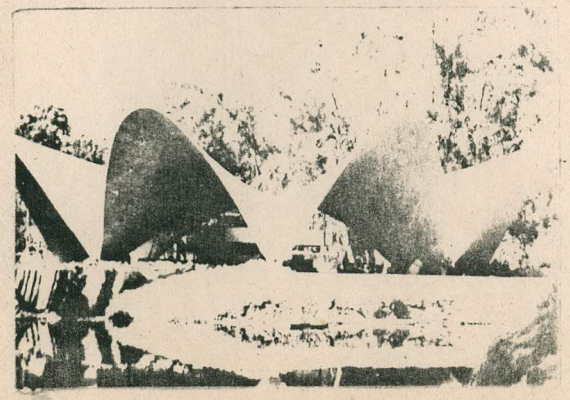
The seminar topic is 'Strength in Form'. As the topic suggest it is very broad and there is no end if we discuss but as it comes under product design course the discussions were restricted only to those topics relevent to product design.

The purpose of this seminar is to foster an understanding of formative processes that will lead the designer to built environment towards solutions which are consistent with first principle of nature i.e. those solutions which are energetically conservative, adaptive and functional. The creation of arbitrary form-that is, form created without regard to its fit with natural phenomena-is often a source of in efficient and ineffective use of material, energy and human resources.

To minimize the arbirariness of form in the built environment is to maximize its performance. To maximize performance is to accomplish objectives in the most effective manner while minimizing the use of energy and material resources.

The fulfilment of performance requirements is at the root of all natural structures. If an organism does not fulfill its function or if it does not perform efficiently, it does not succeed. Fintness is determined by effectiveness and effectiveness is a function of efficient least energy performance.





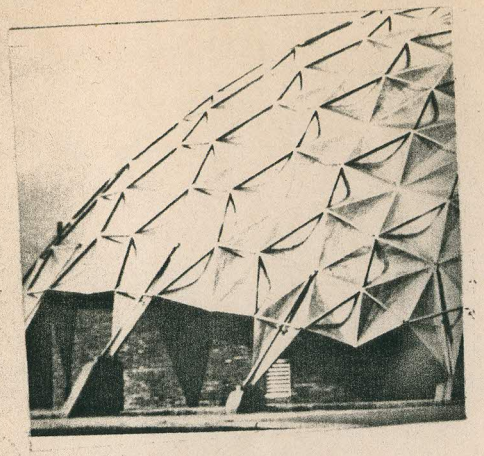
Analysis

In nature, forms and structures are created according to principles of least energy i.e. natural first principles. The form of an object is a diagram of forces that are acting or have acted upon it, in this strict and particular sense it is a diagram.

In order to facilitate a design strategy based upon the principles of form as a diagram of forces, one has to understand the concept of forces. A forse may be considered any governing influence that may act to determine the form of a particular design soulation. In nature, the form of any structure is determined by the interaction of two fundamental classes of forces, 1. Intrinsic forces and 2. Extrinsic forces.

Intrinsic forces are those governing factors which are inherent in any particular system, that is the internal properties of a system which governs its possible arrangements and its potential performance. Extrinsic forces are those governing influences which are external to any particular system. They are the innovatory of factors, largely environmental which gives direction to the form options allowed by the enherent form-giving properties (intrinsic forces) of a given physical system.

In the creation of the manmade environment extrinsic forces can be considered in design goals-the various whim sical,



philosophical, aesthetical, or performance oriented criteria which may be imposed on the design form.

CLASSIFICATION :

Forms can be classified in many ways. This has been found that following classifications will help us in generalizing the study-

NATURAL FORMS :

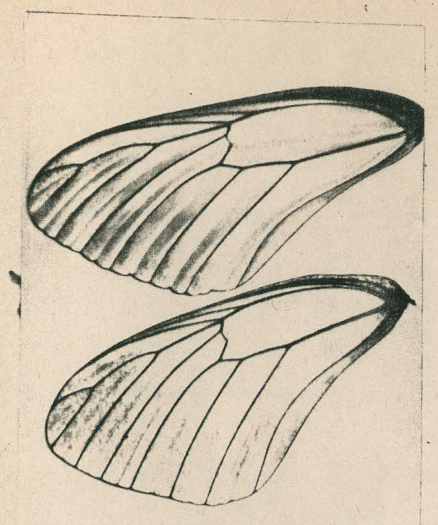
The following are the representative examples of natural forms as a result of least energy principle.

1. Bee's honeycomb :

The hexagonal form of a bee's honeycomb contains the greatest amount of honey with the least amount of bee's wax and is the form that requires the least amount of energy for the bees to construct. The construction material, bee's wax has its own properties or intrinsic forces. The anatomical makeup and genetic instructions that enable the bees to construct a comb constitute the extrinsic force system.

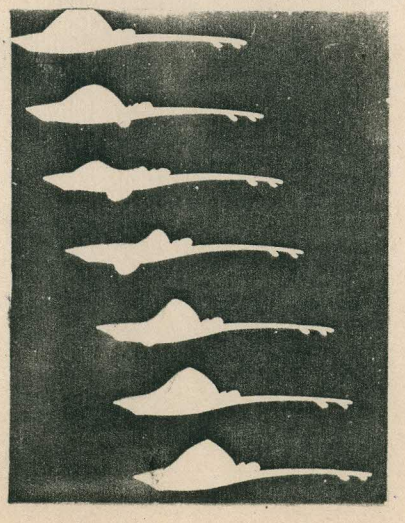
2. Soap Bubbles :

A randsom array of soap bubbles is an elegant demostration of nature's minimal principles. The focres of surface tension seek a state of stable equilibrium that satisfies the conditions of minimum potential energy. This is relative to volume is minimized - a multidirectional closed cell. The air pressure within each bubble presses outwardly against the membrane of soap. In all bubble arrays, all faces meet neighbouring faces on common edges in sets of three at angles of 120°. All edges meet at corners in sets of four at angles of 109° 28'. When surface to volume is minimized these angular coordinations will always be meet, without exception.



3. Dragonfly's Wings :

A simple example in nature of a basic principle of structure is found in the wings of dragonfly. The manner in which these pivoting wings functions requires that a certain amount of stiffness be provided in the wings from an oblique angle reveals a folded structure. The deepest folds occure at the leading edges of the wings. This creates a wing structure of high stiffness relative to weight. It is also likely that aerodynamic lift is increased by the three dimentional wing structure as it creates a visual airfoil. High performance at low energy conspires to optimize the form of this successful creature.



4. Fish :

The aerodynamic form of fast moving fishes like sharks, eels and waterbuffalos are also based on natures principle of least energy.

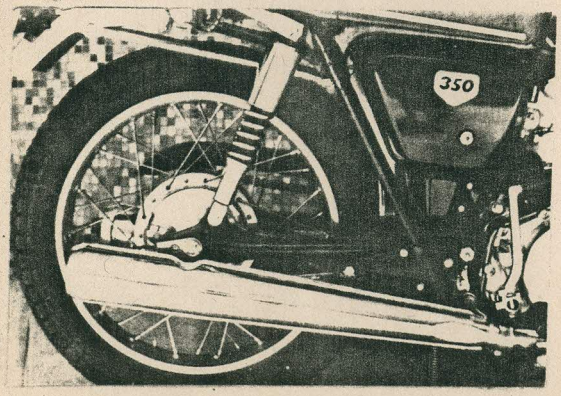
The other interesting forms on same principle are human skull, bone structure spiral shell, eggshell, peanut shells.

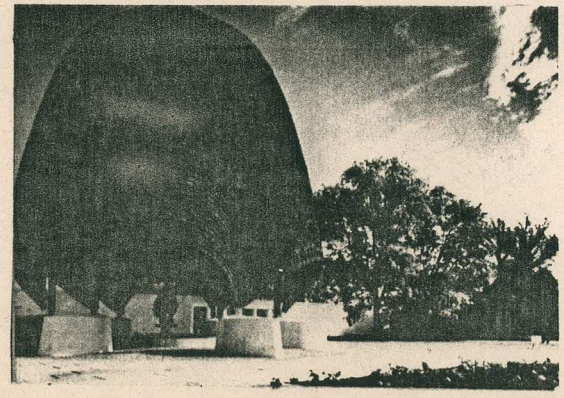
The shapes of all living things have a purpose, if the purpose is not fulfilled the shape sooner or later disappears. Manmade objects, too, have a purpose and only those shapes which serve their purpose best are developed. When a new need appears a new shape must be invented to match it.

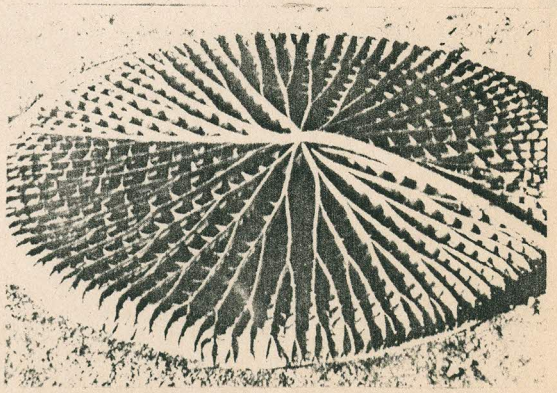
VISUAL STRENGTH :

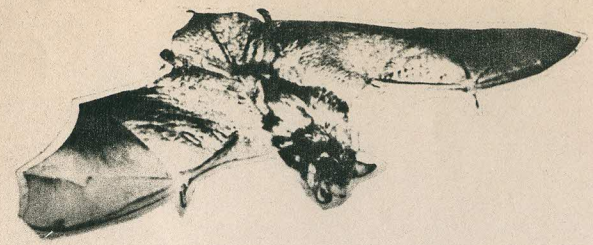
Most of the times our judgements about our visual encounters are made with a primary emphasis on sight. From previous experience we often assume some of the other sensory data. Just looking at shapes and forms can give us innumerable clues as to the nature of the object, how it functions, how itssurface would feel, what it would taste like if edible, and how surface would feel.

The surface of a form is one quality that not only informs but also delights the eye,. The surface regulates the speed with which we survey a form. Smooth forms tend to accelerate our eye speed and textured surfaces slow down theprocess. The size of the texture produced by protruding forms regulates the visual swiftness of our sight across a form.



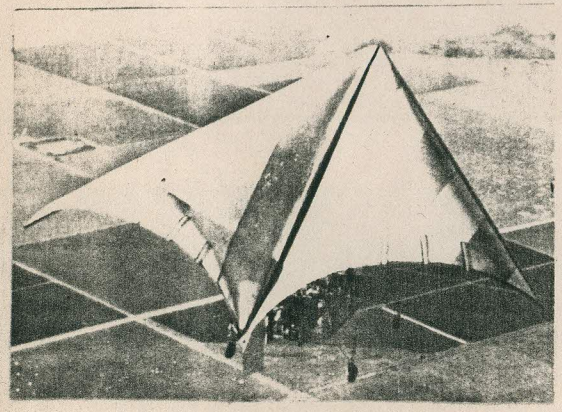


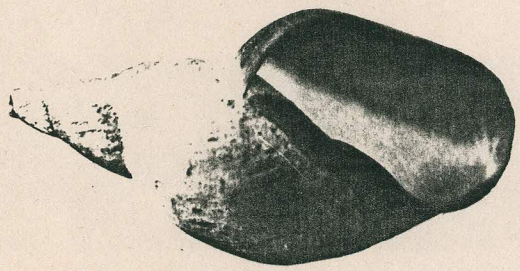


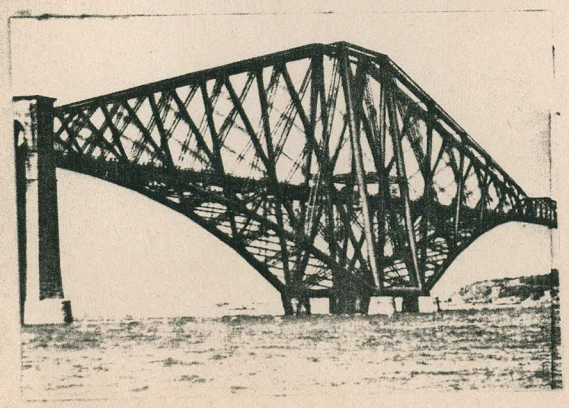


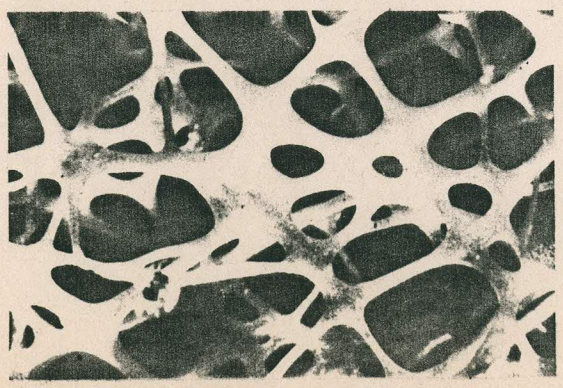
SOME MANMADE FORMS DERIVED FROM NATURAL FORMS :

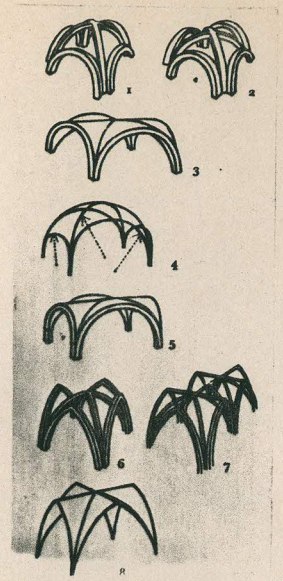
1. Air plane - Fish
2. Hang glider - Bat
3. Steel bridge - Bone structure
4. Turbine - Spiral shell
5. Pneumatic structure - Honey comb
6. Airplane nose - Egg shell.











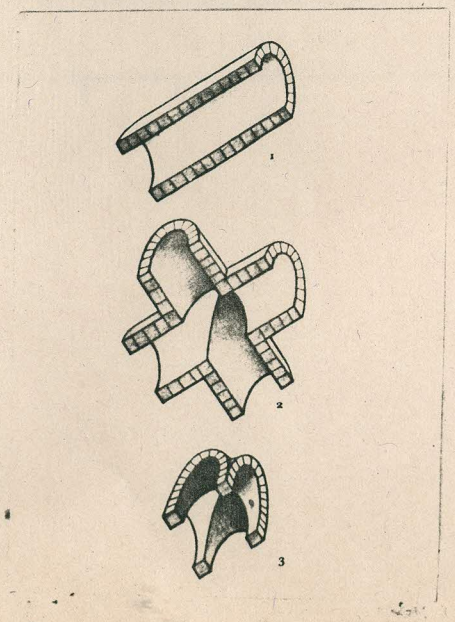
PRINCIPLES USED FOR INCREASING MECHANICAL STRENGTH :

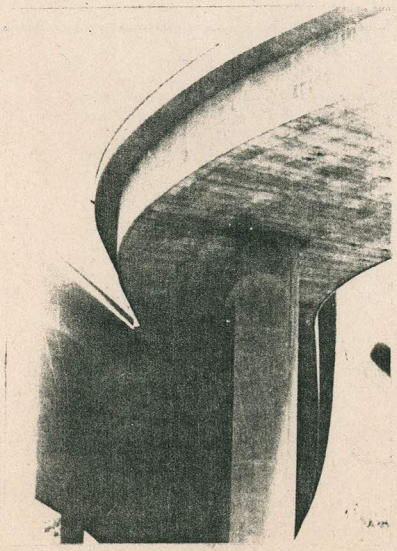
Increasing Bending Strength by reinfor¬cing :

A curved or rolled up piece of paper is more stronger than flat piece, so is a curved piece of reinforced concrete stronger than a flat piece.

The reinforcement can be as folds in one direction, strength can further be increased by giving folds in two directions i.e. bidirectional folds, multidirectional folds.

Reinforcement can be achived by giving curves in one direction, two directions and multidirection.





CONCLUSION :

It has been observed that visual strength of a form can support the mechanical strength as well as it can act in opposite direction. It means few form look very strong when they are physically strong, in nature we see examples like banayan tree, Rhino, Bull's horns, Stone clifes, all these examples look quite strong and actualy they are strong but there are many examples in nature when the visual strength naver matches with physical strength of form either the form looks stronger than it actualy is or it looks likea weak form while it is quite stronger. The examples are human skull- by looking at it, it looks quite fragile and one feelsas it will break when hammered or droped on the floor while in reality it is designed to with stand considerable amount of shock, egg shell - the form has strength higher than anyother form with similar material composition and dimentions, its resistance for extrinsic forces is very high.

Stability and dyamamism in a product also affects the visual strength in it. The product looks mote stronger when it has more stable base, thicker supports.

Product Designers can make use of these studies . Many of the times he comes across the situation when he has to show certain products looking stronger while they are weak and vice-versa.