

Design Course

## Elements of 3 Dimensional Design

Towards Design of Objects

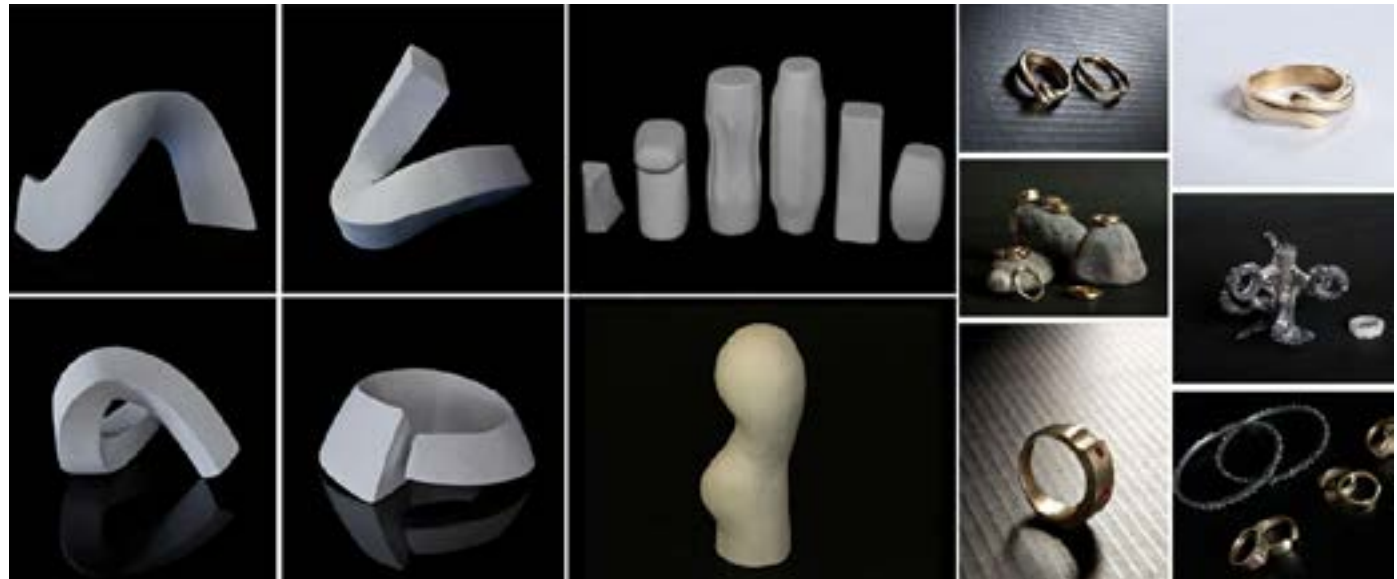
by

Prof. Ravi Mokashi Punekar

DoD, IIT Guwahati

Source:

<https://www.dsource.in/course/elements-3-dimensional-design>



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<https://www.dsource.in/course/elements-3-dimensional-design/introduction>

## Introduction

A visual artist is a general term used for any person interested in the visual studies. Such a person may be a painter, a potter, graphic designer, sculptor or a product designer.

**Aims:**

This course has been developed for a person interested and self motivated in becoming a visual artist. It aims to help one in imbibing the following qualities of a good designer:

1. Observation
  - Training off mind one's mind
  - Being observant of surroundings
2. Imagination
  - Visualization sense
  - Dreaming/Imagining things in one's mind
3. Ideation
  - Conceptualizing
  - Thematic brainstorming
4. Representation
  - Skill based Concretization of the imagination/idea
  - Requires manual labor/practice
  - Manual Skills such as sketching, rendering
  - Software Skills
  - About maintaining the value of the ideas
5. Communication
  - Of one's ideas
6. Documentation
  - Keeping track of one's work, for reference/inspiration

It encourages learning by doing. It encourages analysis and discussions on the work done.

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**Objectives:**

- This course will help you to understand the basic vocabulary of visual perception.
- To gain access to information that is conceptual, technical or aesthetic in nature related to visual design.
- To appreciate theoretical concepts related to visual design by undertaking simple assignments in visual design.

The course is divided into the following three modules:

## Module 1

Elements of Design - 2 Dimensional Design Studies

- Conceptual Components
- Visual Components
- Spatial Representations

## Module 2

Elements of Design - 3 Dimensional Design Studies

- Form – Fundamentals
- Form Analysis
- Form and Structure

## Module 3

Elements of Design – Color Studies

- Visual perception
- Color Terminology
- Color interaction

This is a module on exploring **Elements of Design - 3-Dimensional Design Studies**.

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## Form - Fundamentals

The visual language is the basis of design creation. To design is to endow optical sensation or images with meaning.

In the previous module: Elements of Design - Two – dimensional Design Studies, the following three aspects of visual design were introduced and it was illustrated how Conceptual elements do not exist physically, but are perceived as being present; and that Visual elements can be seen and are considered as final elements of the design.

Further the principles and rules of concept and visual design were also discussed.

In this module: Elements of Design - 3-dimensional Design Studies, we will further elaborate on the consideration of:

- a) **The Conceptual Elements:** Volume, Plane, Line and Point
- b) **The Visual Elements:** Shape, Form, Space, Size, color and Texture
- c) **The Relational Elements:** Position, Directions, Space and Gravity

**Aims:**

- To strengthen an understanding of form, space and structure by exploring the sculptural qualities of 3-dimensional form.
- Enhance understanding of 3-dimensional visual perception.
- Creating and analyzing 3-D form and space inter-relationships when they manifest in 3-dimensional form, space and structure.
- Enhance understanding of visual design as seen and experienced in objects and artifacts that surround us in our environment.

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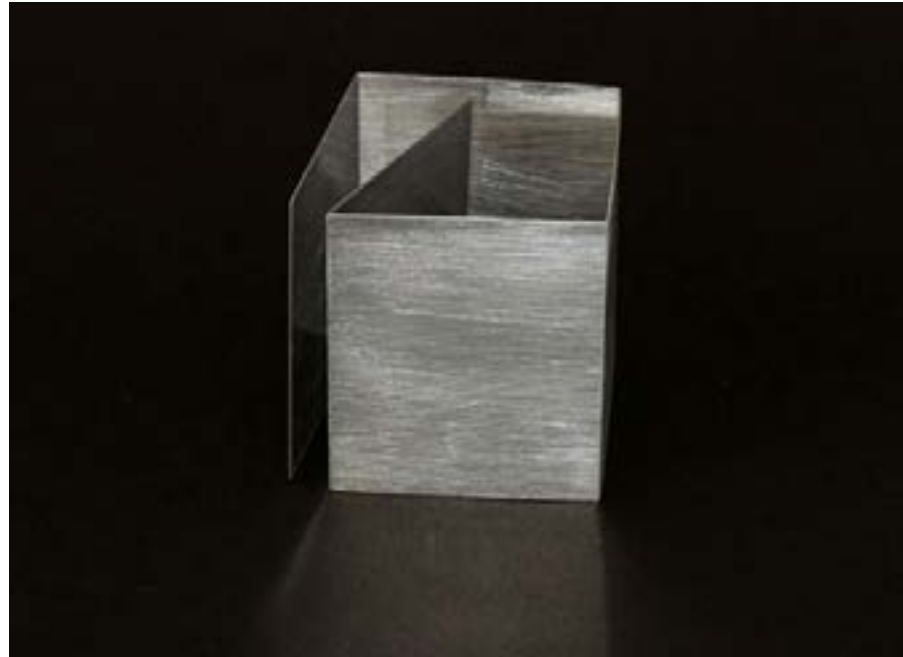
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## Elements and Properties

Different 3-D Visual Elements and their Properties are listed below:

### Volume:

Volume is a 3-dimensional element expressing height, width and depth. The boundaries of the volume are defined by surfaces. The properties of the inner mass are reflected in the movement and shape of the surfaces. These surfaces can be divided by hard transitions creating the boundaries of the planes. The boundaries/ edges represent the lines of the volume and the corners on the volume are the points.

### Plane:

Is an elemental part of a volume. When the surfaces on a volume have clearly defined edges so you can discern its shape and contours, a plane is delineated.

Plane has lines and points as its elemental parts. A plane can also exist independently in space and is a 2-dimensional element expressing width and length.

### Line:

Line is used to delineating the shape of a plane and the hard transitions between the surfaces as they form the edges of a volume.

Line has points as its elemental parts. An independent line in space articulates 1-dimension expressing length.

### Point:

Is an elemental part of a line. It can be visualized as the start and end of a linear element and the corner points of a volume. A point has no elemental parts and no dimensional movement, yet it expresses position.

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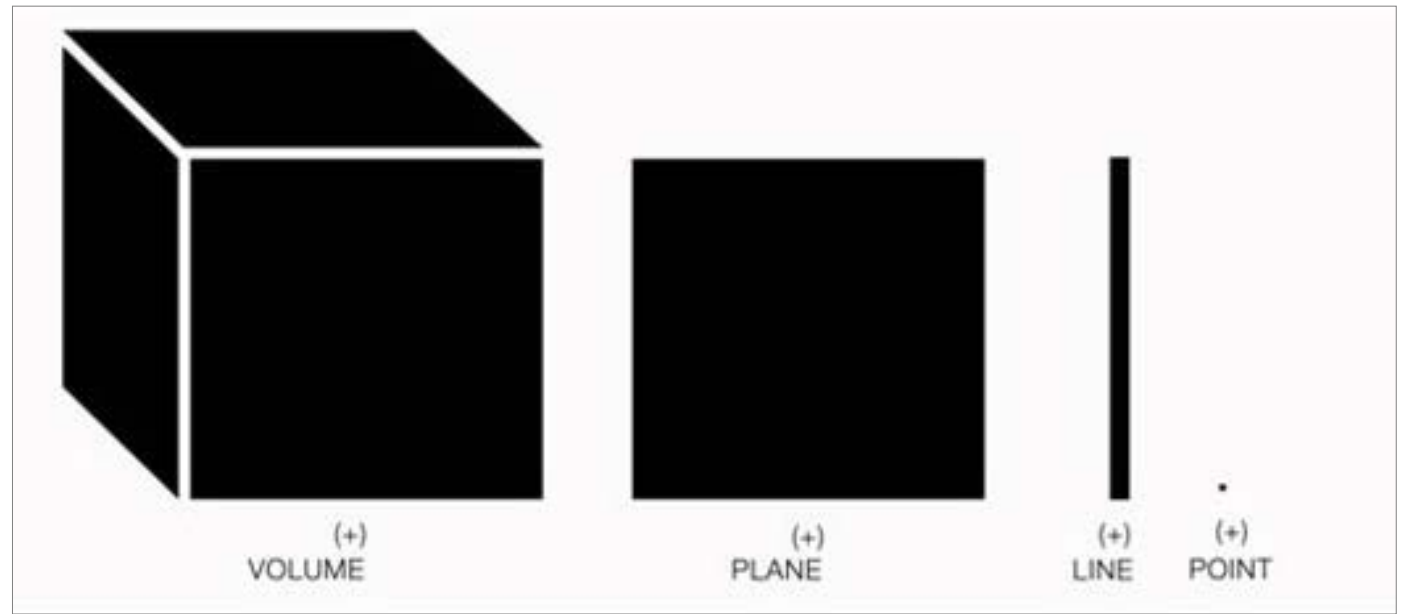
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## Form and Space

### Positive Elements and Negative Elements:

The **definitions of the Elements**; Volume, Plane, Line and Point apply to tangible form i.e. Positive elements. However, the **Basic visual elements** can also include spatial enclosures i.e. Negative elements.

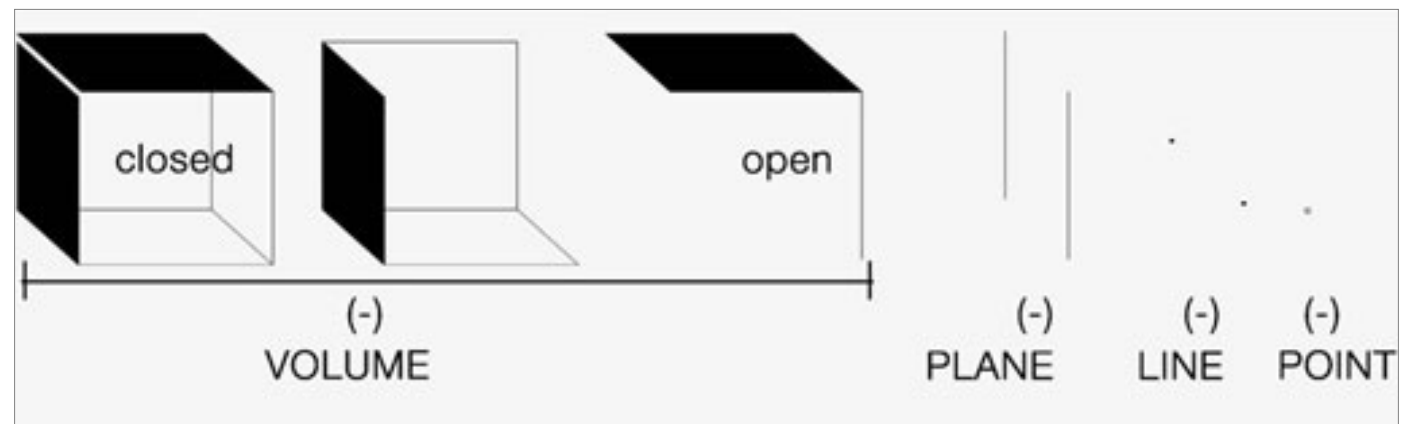
Positive and Negative elements are similar in that they can both be described as visual components with more or less defined boundaries.

A positive element form cannot be perceived unless it exists in a spatial context and vice versa. i.e. Form and Space are complimentary. One cannot exist without the other.

Negative elements are defined within the space between any of the positive elements.

We are raised to see and discern objects rather than the space between them. Therefore, it is more difficult to comprehend and perceive negative spaces.

The elements of negative of spatial enclosures are more varied than the positive elements and the strength of the spatial enclosures is dependent on the strength of spatial articulation of the surrounding positive forms. They are dependent on movements and forces inherent in the relation between the elements.



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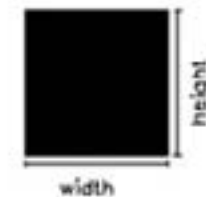
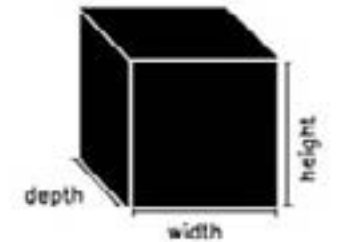
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## Dimensions of Elements

Dimensions and its Characteristics are given below:

Dimensions of Elements	Characteristic
Height (H)	implies a vertical direction in space starting from the base and moving to the top.
Width (W) and Breadth (B)	imply movement from side to side
Depth (D)	means the direction backwards or inwards
Thickness (T)	has no spatial correlation and is usually the smallest measurement of an element.
Length (L)	also has no spatial correlation and is usually the measurement of how long is an element.



\* position

Element	Dimensions		
Volume - 3D	H	W	D
Plane - 2D	L or H	L or W	
Line - 1D	L (only)		
Point - 0 D	Only position		

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## Inherent Proportions

Inherent proportions involve the direct correlations of one element part to another.

**For example:**

The measurement of the length and width of a plane determine the exact length of the lines that border it. If proportions of the plane are changed then the length of the lines will be altered in correspondence to the plane.

A cube comprises of the elemental parts planes, lines and points to limit its total mass and to delineate and punctuate the transitions between surfaces. All six planes on the cube are identical in size and all the lines on the plane are therefore the same length.

Element	Dimensions
Cube Geometric volume with all sides equal - 3D	
$H = W = D$	
Plane - 2D	
L or H x W	
Line - 1D	
L (only)	
Point - 0 D	
Only position	

Inherent proportions involve the direct correlations of one element part to another.

The change in the width of one plane directly affects the proportions of three planes including its edges(lines) as well as the relative inherent proportions of the entire volume.

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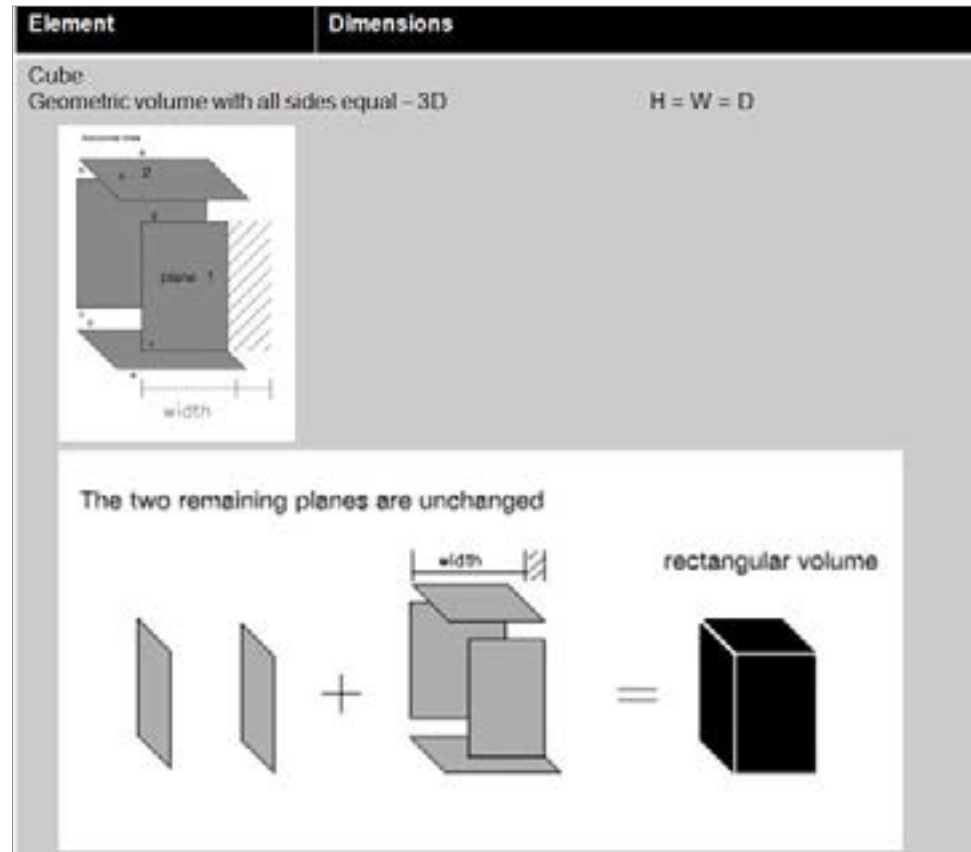
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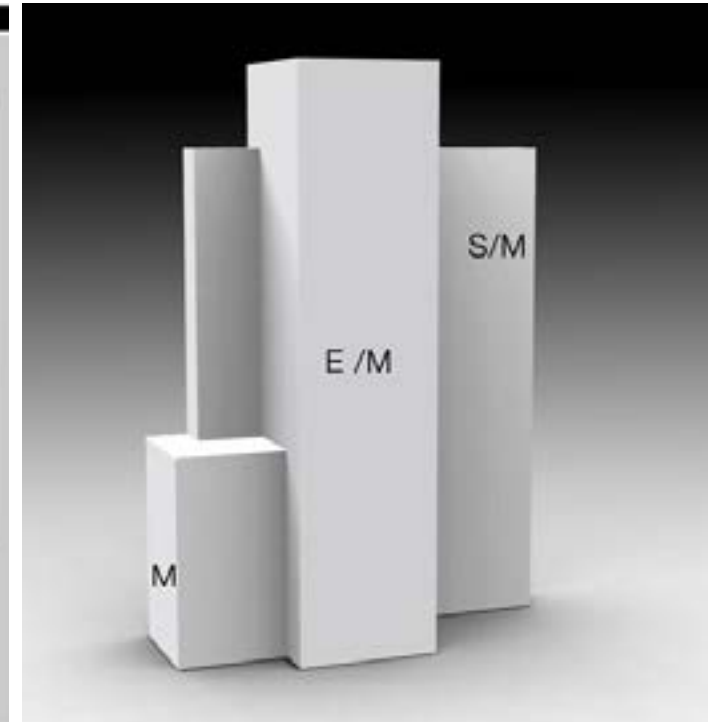
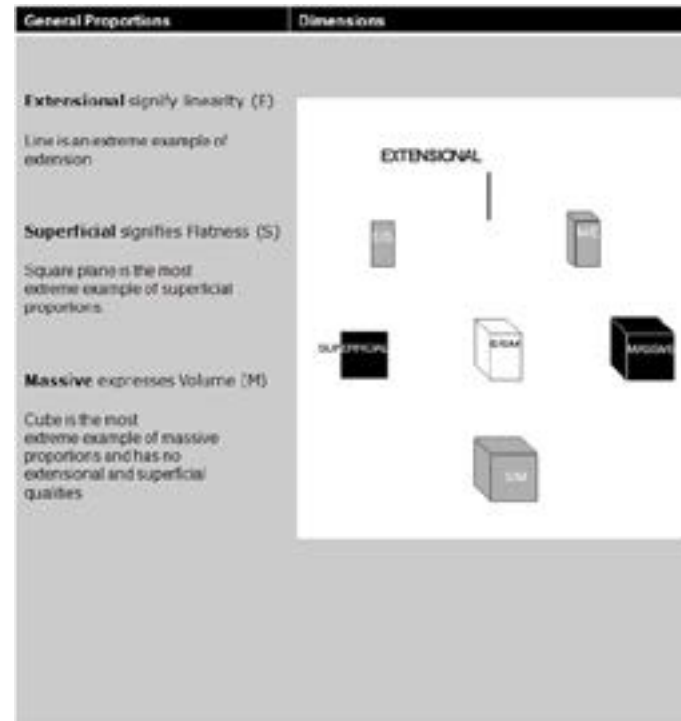
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## General Proportions

General proportions involve overall proportions of an element.



The interaction between extensional (c), superficial (a) and massive (b) rectilinear forms.

**Note:** The nature of joints in this interaction of rectangular forms.

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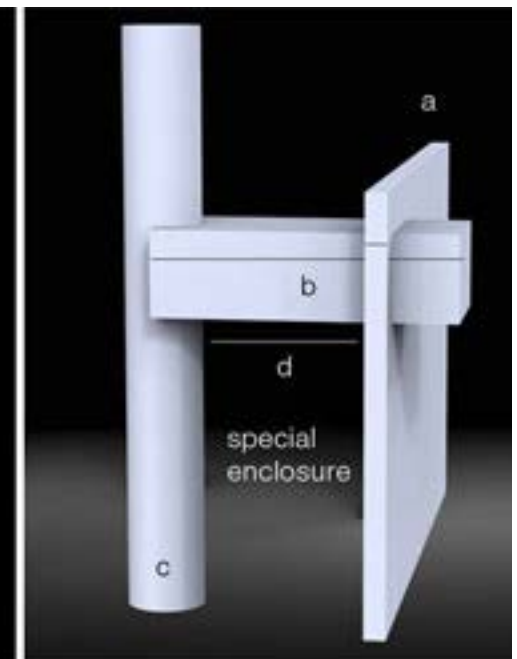
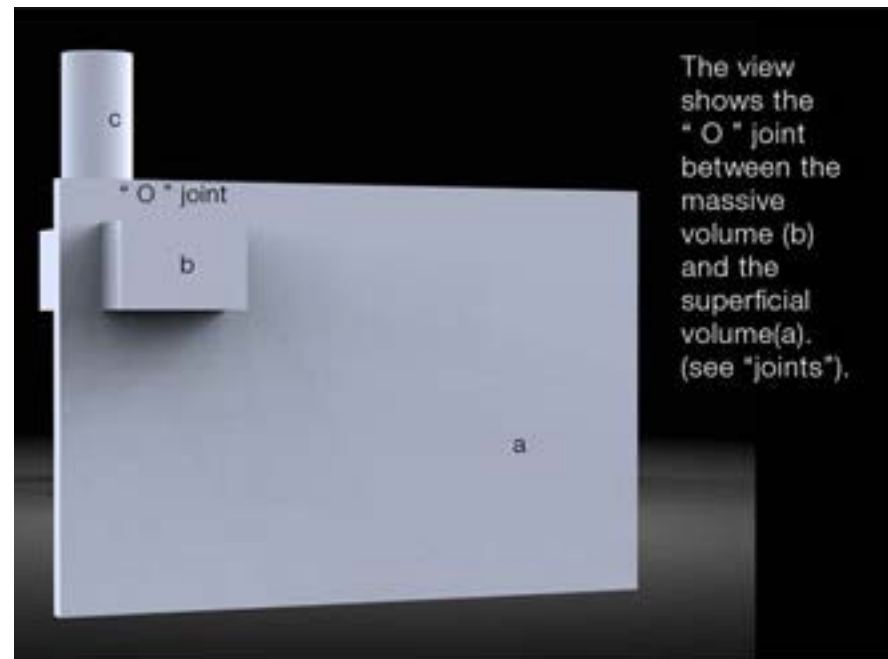
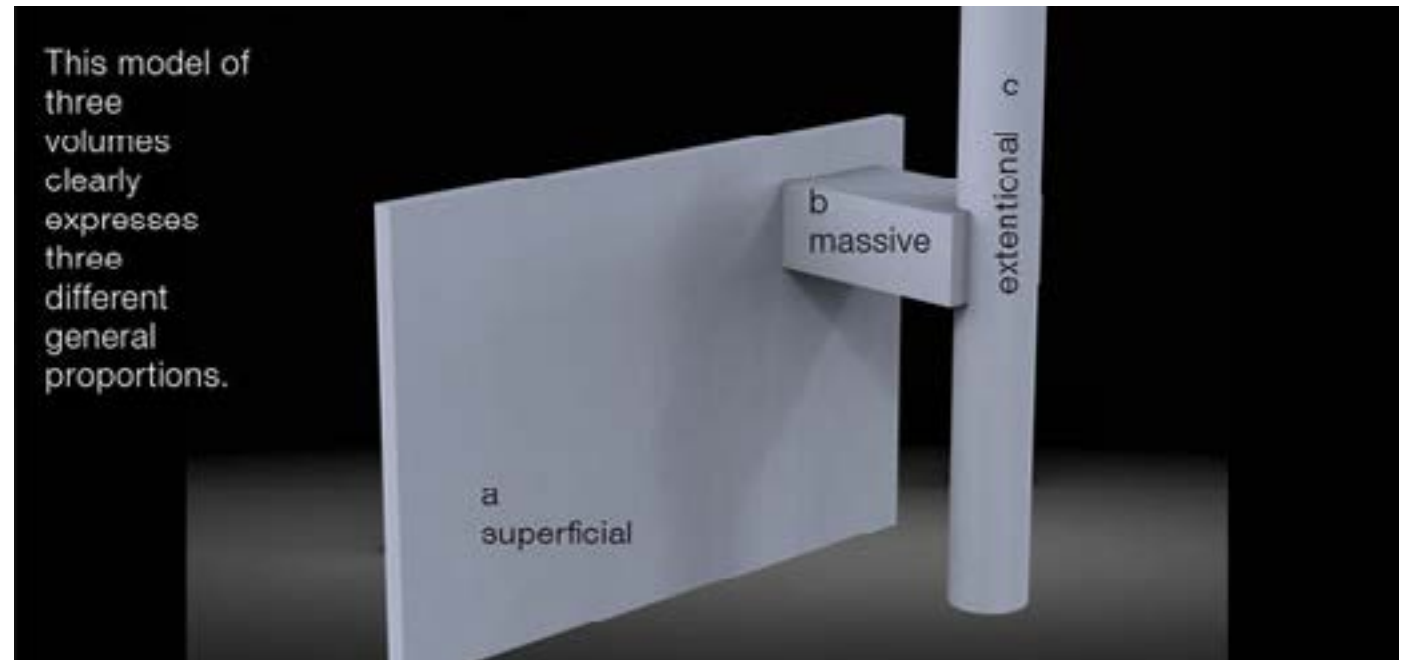
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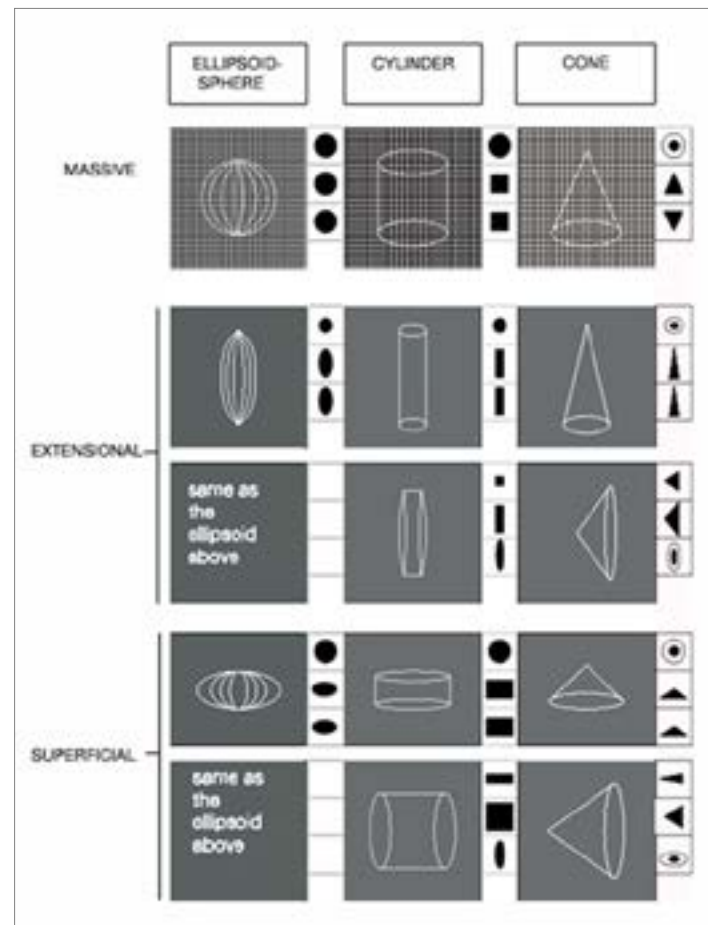
## Curved Primary

### Basic Curvilinear Geometric Forms:

The three families of curved primary Geometric volumes are:

- Ellipsoid / Sphere
- Cylinder
- Cone

All three curvilinear massive volumes have equal parameters for height and diameter. The other volumes show how the primary volumes vary in general proportions: extensional, superficial and massive.



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Three Sections of Volume in X – Y – Z axis:

- Geometric Planes derived from all Ellipsoidal / Spherical volumes are circles and ellipses.
- Geometric planes derived from cylindrical families are Circle/ellipses and Squares and Rectangles.
- And those from the conical family are circle/ellipses and triangles.

CONE	SECTION	GEOMETRIC PLANES		
		CIRCLE ELLIPS	SQUARE / RECTANGLE	TRIANGLE
	 horizontal			
	 vertical			
	 depth			

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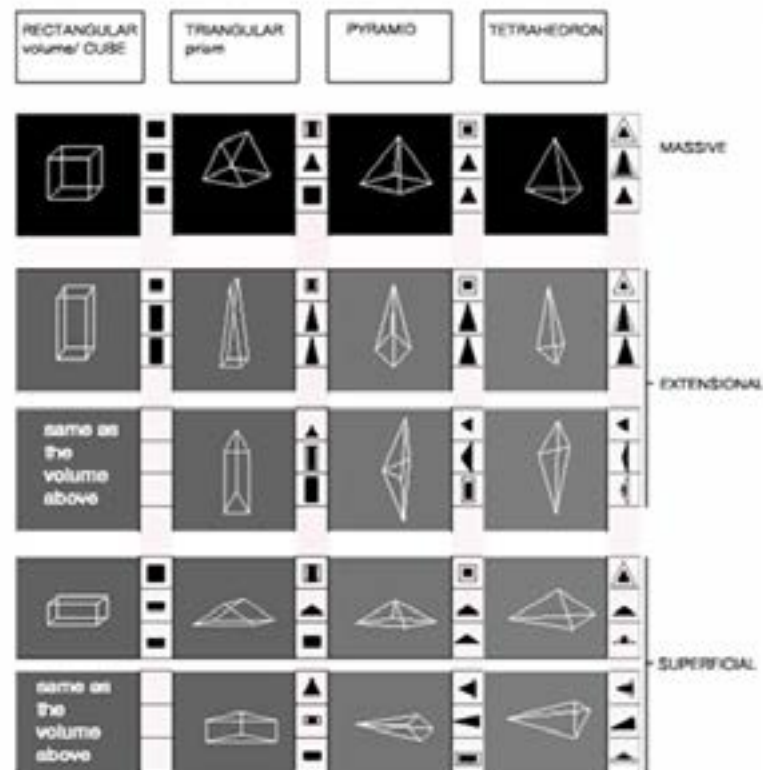
## Straight Primary

The four families of straight primary Geometric volumes are:

- Rectangular Volume / Cube
- Triangular Prism
- Pyramid
- Tetrahedron

All three Straight massive volumes have equal parameters for height and base while the tetrahedron is equal in height.

The other volumes show how these Primary volumes vary in general Proportions: extensional, superficial and massive.



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**Cross Section of Straight Geometric Volumes in X – Y – Z axis:**

- Geometric Planes derived from the rectangular volume family are squares/rectangles.
- Planes derived from the triangular prism family and Pyramid family are triangles and squares and rectangles.
- And planes derived from the tetrahedron family are regular or irregular triangles.

GEOMETRIC PLANES	
SQUARE / RECTANGLE	TRIANGLE
	
	
	
	

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## Primary Geometric

Different Geometric form families are listed below:

### Sphere:

Sphere forms a part of the Ellipsoidal family. It is visually the simplest form because it is perfectly symmetrical from all views. The single continuous double-curved surface which is at an equal distance from the center creates circular contours with no articulated axes. A sphere can only change in size.

### Ellipsoids:

Ellipsoids are also defined by one continuous double-curved surface, but the distance from the center gradually changes through elliptical curvatures. The ellipsoid can change its proportions along one, two or three axes.

### Cylinder:

A circular cylinder is symmetrical around the rotational axis and from top to bottom. The elemental parts are a simple curved surface and two flat circular surfaces that are parallel to each other.

The simple curved surface meets the two flat planes at the right angle and outlines their circular edges. The cylinder can change its general proportions through extension or contraction along its rotational axis.

It can also alter its proportions by changing the neutrally circular simple curved surface to an accentuated elliptically curved surface. The outline of the two base surfaces then changes from circular to elliptical.

### Cone:

The circular cone is a very dynamic volume because of the diagonal contour of the form due to the changing diameter of the curved surface. The elemental parts of the cone include one simple curved surface that wraps around the volume, one flat surface with a circular contour and one vertex point. The movement of the curved surfaces creates a circular edge on the flat base. At the top of the volume where the curved surface comes together at a single point, the vertex is created.

The simplest way to change the proportions of a cone is to extend it along its primary, rotational axis. However other proportional variations that vary the width or depth, requires that the curved surface follows an elliptical curve and that the base plane of the cone changes to an elliptical plane.

### Rectangular Volume/ Cube:

Cube is a special kind of rectangle. It is the simplest straight geometric volume because its elemental parts are all identical and the composition of the elements is at right angles and parallel. The six planes are all squares

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of equal size, which fixes the inherent proportions and allows no variations in width, depth or height. The only changes that can occur are in scale.

The rectangular volume is constructed of six parallel planes in right angle relationship to each other. Variations of proportions of a rectangular volume can occur along all three axes

### Pyramid:

A Pyramid has similar features to a cone, such as the diagonal contour of the form and the vertex point at the top. The elemental parts of a pyramid are four triangular outlines and a fifth plane which is square or rectangular. The triangular planes meet at the vertex and form the sides. The square or rectangular plane forms the base. The change in proportions is determined by the rectangular proportions of the base and the height of the vertex.

### Triangular Prism:

A triangular prism is symmetrical between the two parallel triangular planes and out from the primary axis. The elemental parts include three rectangular or square planes that are at an acute or obtuse angle relationship to each other. The degree of the angle between the rectangular planes defines the shape of the two triangular planes. Changing the general proportions of a triangular prism by varying the distance between the two triangular end planes involves no structural changes in the angles between the elements. However, changing the proportions that vary the length of the sides of the base triangles introduces new angular relationships between the sides of the triangles and the rectangular surfaces.

### Tetrahedron:

Tetrahedron is the simplest 3D closed volume that can be constructed of flat planes. It is structurally the most stable form of all primary geometric forms, yet visually it emphasizes the dynamic edges and the opposing movement between the pointed corners of the form. The equilateral tetrahedron is made up of four identical equilateral triangular flat planes and has structural similarities with the cube. Proportional changes can be made by varying the angular relationship between the surfaces which directly changes the degree of each angle on the triangle as well as the length of the sides of the triangular planes.

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Design Course

## Elements of 3 Dimensional Design

Towards Design of Objects

by

Prof. Ravi Mokashi Punekar

DoD, IIT Guwahati

Source:

<https://www.dsource.in/course/elements-3-dimensional-design/form-transition>

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## Form Transition

The basic character of a product is centered around the identity of that product, that is, its ability to suggest its purpose and function, and the mode of function through its visual appearance. It can be seen that the basic structure of the form must be respected and maintained as the active core of the final form. It is imperative that the transition from one basic element to another must respect these elements without contrasting them superseding their importance.

The transition between the sub-volumes that comprise a product provides the unifying relationship that combines these separate volumes into a unity of meaning as well as unity of appearance. The transition of one form into the other must ensure that the visual flow must be harmonious and smooth.

### Assignment 1:

- Develop a 3-dimensional form to study the form transition characteristics.
- Select any two geometric forms and examine the visual character of the form as it transforms from one underlying structure into the other.

### • Material:

PoP (Plaster of Paris)

### • Keywords:

Form transition, harmony, unity

### • Approach:

To understand the volumetric inter-relationship between form and underlying structure; form and unity between the elements - based on working on the selection of any two geometric forms.

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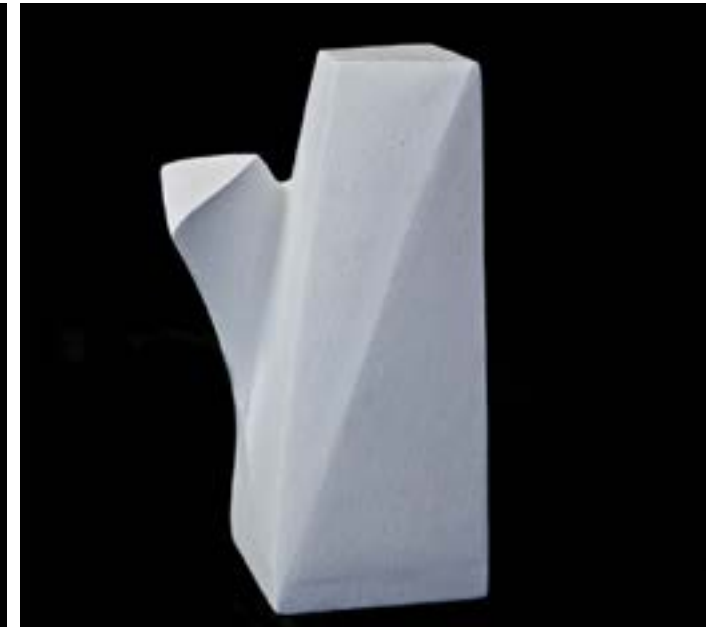
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Merge:



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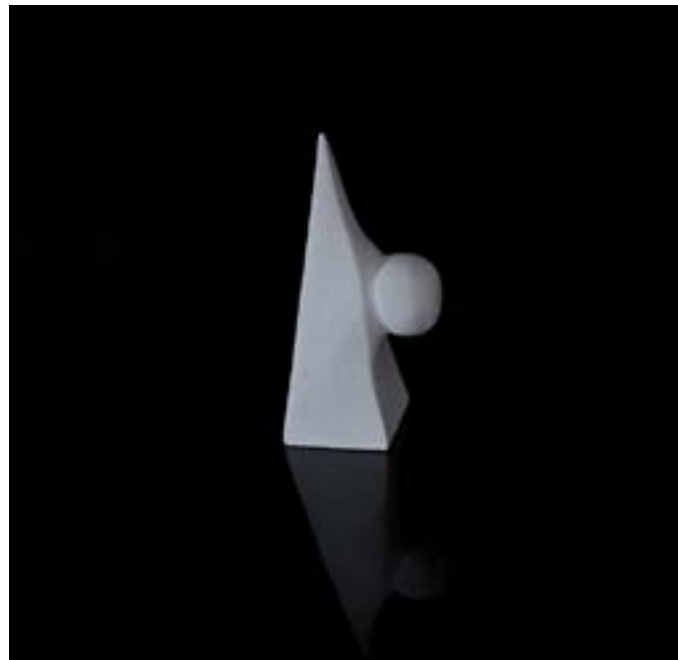
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<https://www.dsource.in/course/elements-3-dimensional-design/movement-and-forces>

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## Movement and Forces

**Form:**

Form refers to the visual and physical structure of an object. It is 3-dimensional. We live in a 3D space surrounded by stationary and kinetic forms. Human beings, like all objects, exist in a form-space relationship. Form and space are complimentary and one cannot exist without the other. Space is an aid to the perception and appreciation of form.

**Form – Movement and Forces:**

The nature of the 3D experience of form is rooted in the perception of the energy and inner structure of form or composition.

In the generation and analysis of the 3-D composition, one must perceive the inner- and spatial activity of the visual elements. These activities encompass the combined effect of the movement of an axis and the forces that act upon it. This visual energy is seen to interact with the proportions and shapes of the elemental parts of the form. These are indirectly perceived through visual clues from the positive form.

The interplay of the surface/plane governs the movement of form. The transition between surfaces in turn controls the position, shape and sharpness of edges as surfaces come together in form. The corners and points add visual detail to the form.

**Assignment 2:**

Selecting two / three sub-forms to develop a strategy for visualization and development of form to communicate:

- Movement and forces
- Hierarchy and visual order
- Twist and bend

Develop design proposals for the same in 3-dimension.

**• Material:**

PoP/ Wood/ Wire or any other material as found appropriate for the design concept.

**• Keywords:**

Form and Communication; Movement and Forces; Hierarchy and Order; Twist and Bend; Visual Perception.

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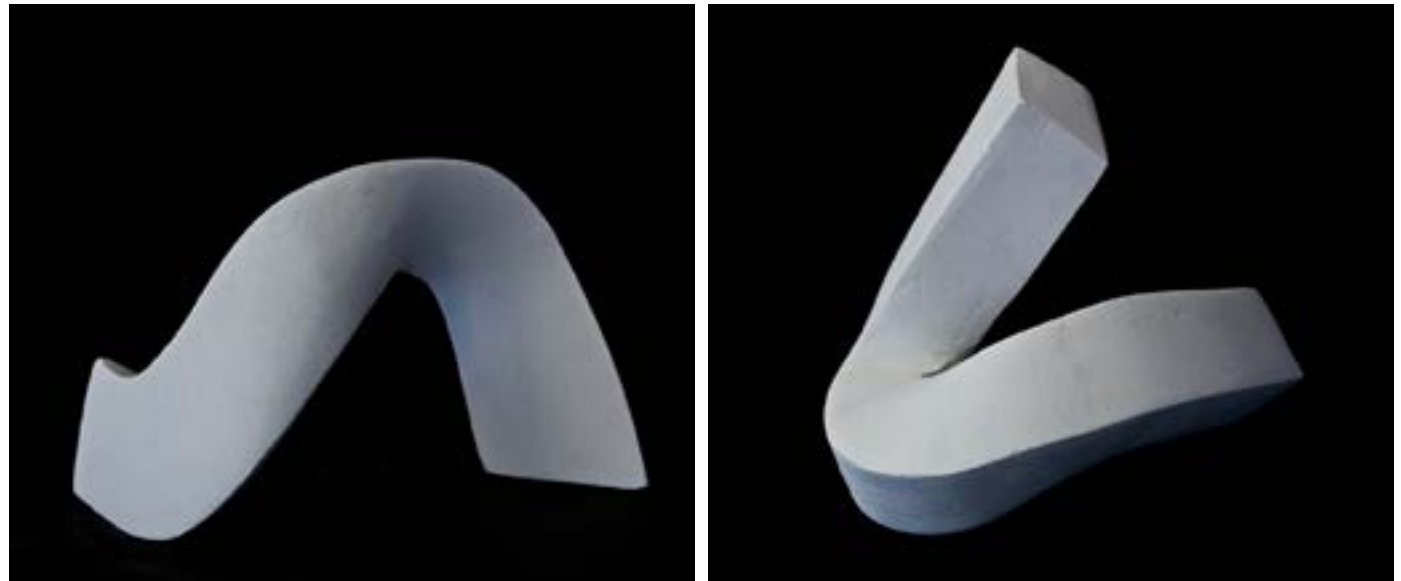
### • Approach:

To understand the personality of the different geometric forms - their hierarchy and order; spatial movement patterns; transformations; their character.

### Twist:



### Twist and Bend:



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## Form and Expression

**Form:**

Form refers to the visual and physical structure of an object. It is 3-dimensional. We live in a 3D space surrounded by stationary and kinetic forms. Human beings, like all objects, exist in a form-space relationship. Form and space are complimentary and one cannot exist without the other. Space is an aid to the perception and appreciation of form.

**Form and Expression:**

The nature of the 3D experience of form is rooted in the perception of the energy and inner structure of form or composition.

Expression of the form can be derived through the selection of any one of or a combination of the following three basic characteristics viz. linear characteristic, the planar characteristic and the volumetric characteristic that constitute the formal elements as they come into interplay with one another. These combinations can be used to derive the basic personality of the form. Application of such a visual language for expression is constantly sought by the designer in various design assignments involving generations of form.

**Assignment 3:**

The different chess coins Rook, Horse, Bishop, King, Queen and Pawn in a game of chess can be an interesting subject for a study in developing a strategy for visualization and development of form to communicate movement, hierarchy and visual order.

Develop design proposals for the family of chess coins viz: Rook, Horse, Bishop, King, Queen and Pawn

• **Material:**

PoP/ Wood/ Wire or any other material as found appropriate for the design concept.

• **Keywords:**

Form and Communication; Movement and Forces; Hierarchy and Order; Texture; Visual Perception.

• **Approach:**

To understand the personality of the different chess coins - their hierarchy and order; spatial movement patterns on the chess board, and evolve alternative form concepts – linear, planar or volumetric - based on creative interpretations of their personality by retaining a 'family-ness' between them.

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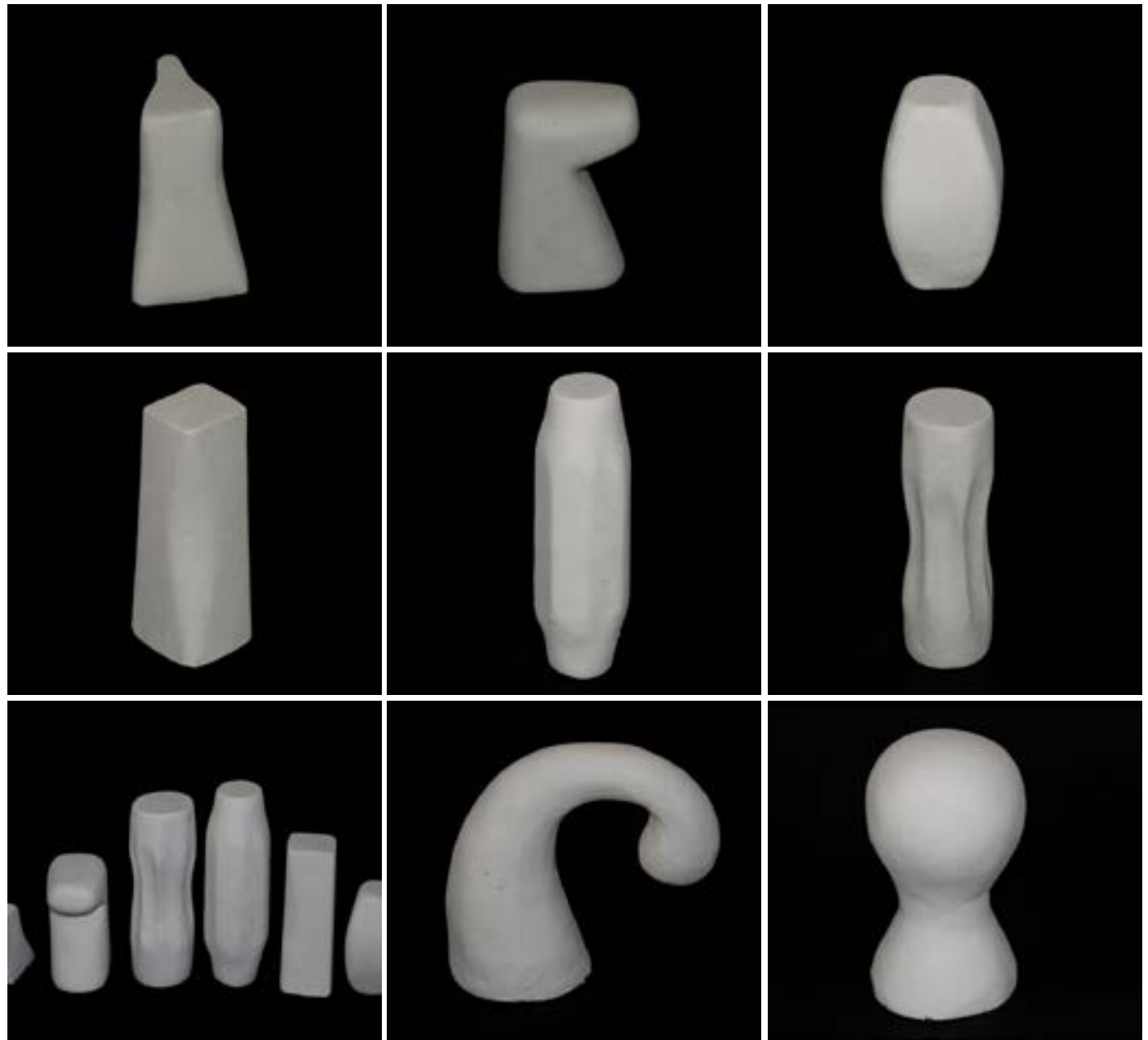
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Volumetric forms:



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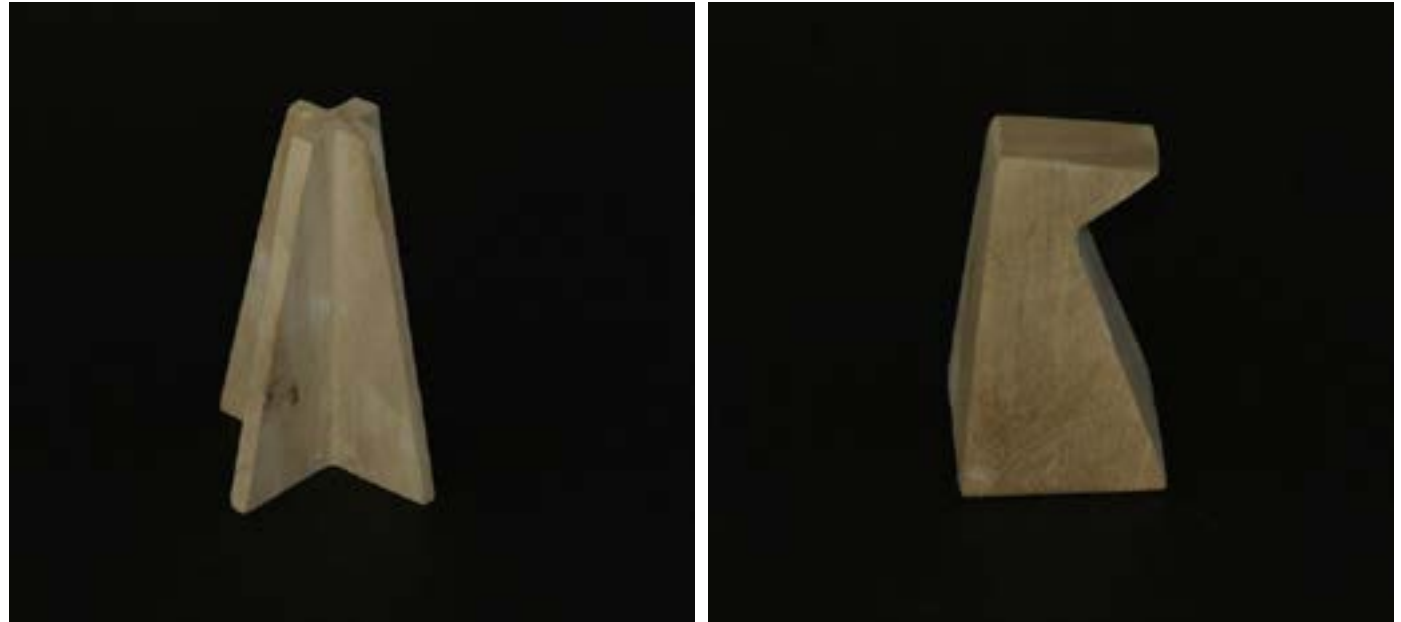
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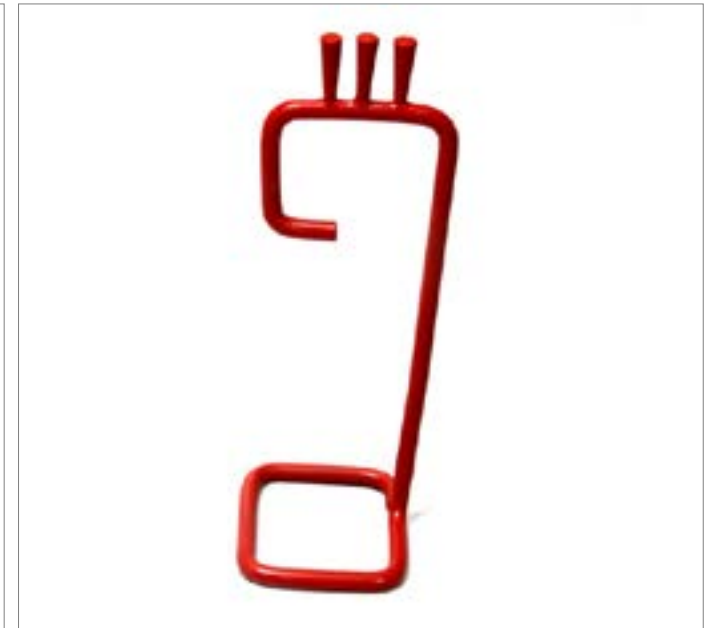
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Linear forms:



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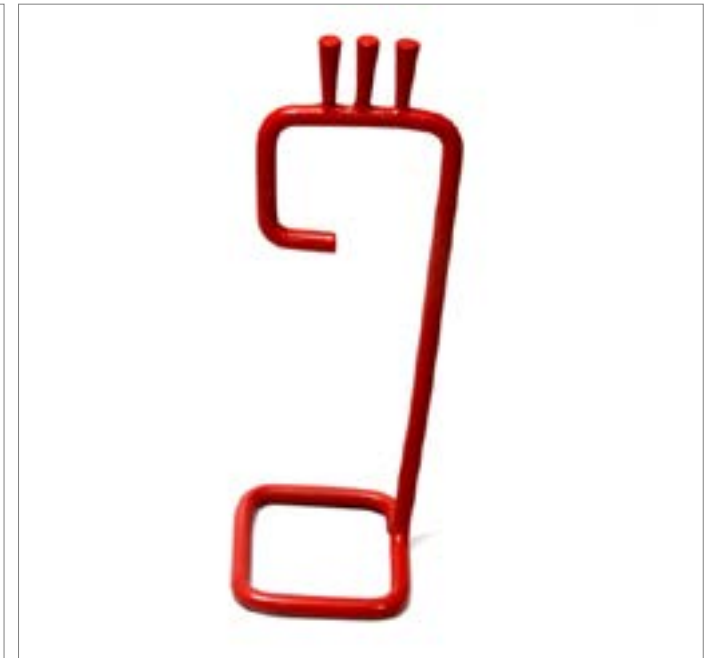
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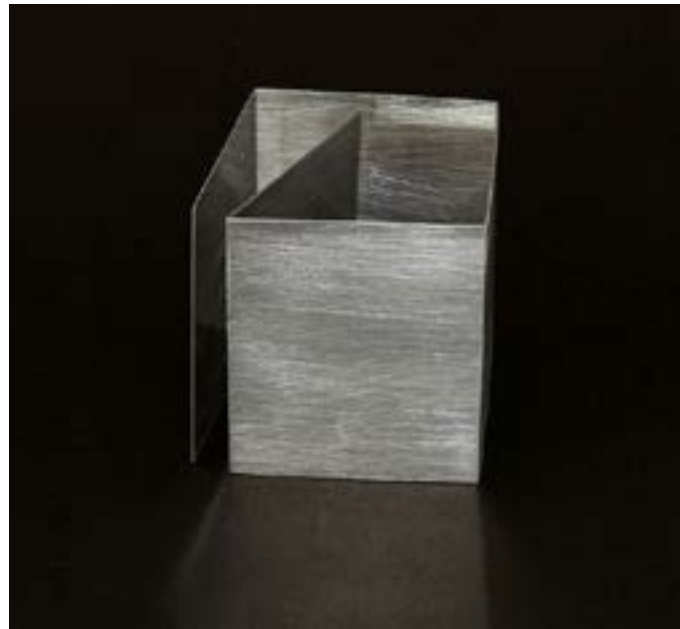
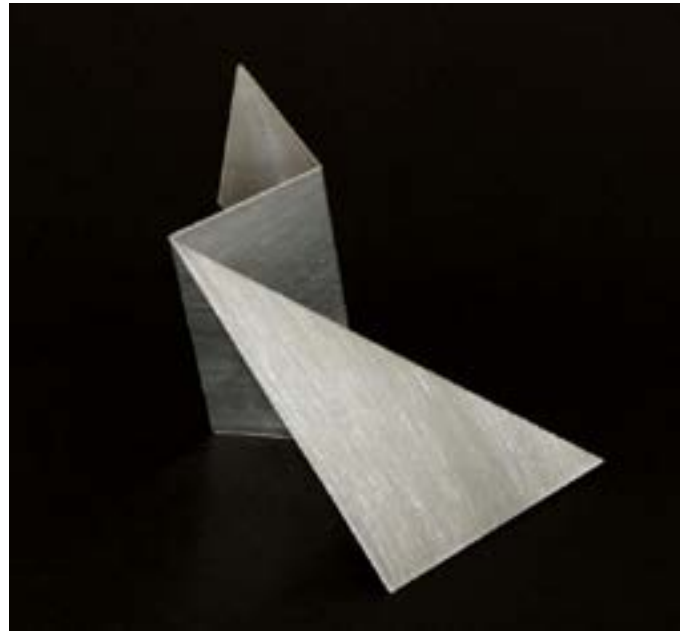
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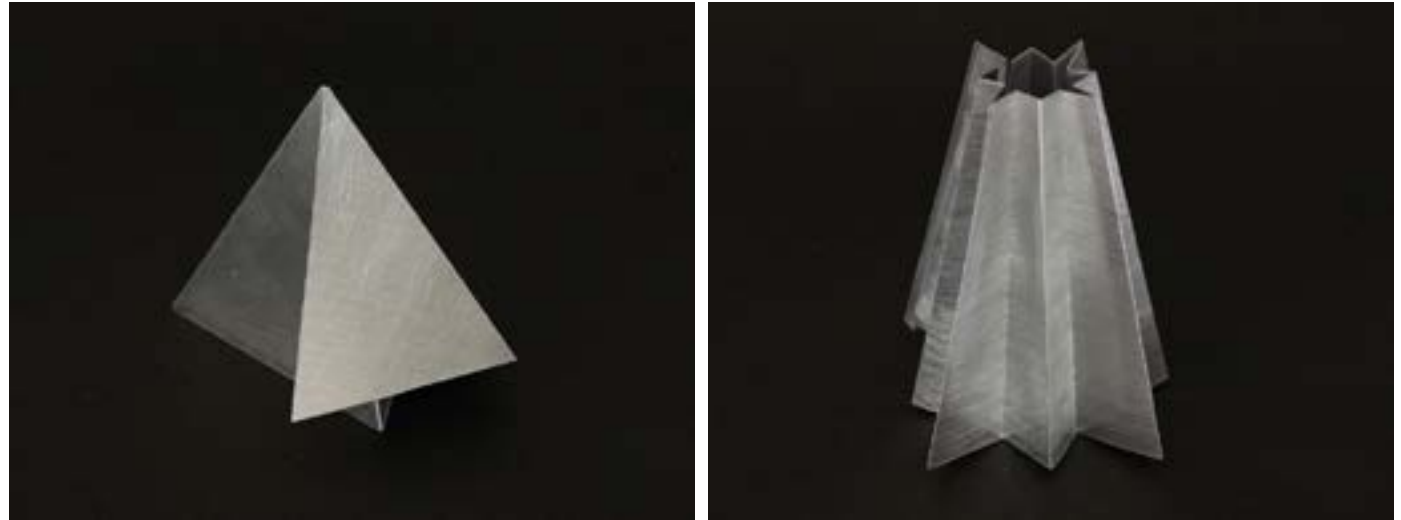
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## Finger Ring

Form expression can be altered through the introduction of new form relationships between the elemental parts of the form. Using geometric volumes as the starting point for development, new formal features, which deviate from the geometry, can evolve through the introduction of a second visual element and examining the transition path of one with respect to the other.

This assignment explores the variation in the development of the crown of a finger ring. It examines the transition of an annular form of the finger ring and the subtle transformation in the formation of the crown of the finger ring.

### Assignment 4:

Body Ornaments form an interesting domain where aesthetic considerations in the transition of the form through the interplay of elements of line, plane and texture along with considerations of anthropometric dimensions, form the predominant criteria in the development of the product form. To develop design proposals for finger rings.

#### • Keywords:

Form and Aesthetics, Form transition, Open form – Closed form, Body dimensions and fit, Texture, Manufacturing and replication for mass manufacture:

#### • Material: Brass rod

#### • Approach:

To size the given piece of brass rod to fit the size of the third figure by machining and turning an annular form. Examine form variations and form transition in the formation of the 'crown' of the finger ring. To understand the process of sculpting the 'master form' of the design proposal; and understanding the process of replication for mass manufacturing using simple rubber molding techniques, casting processes in paraffin wax and casting in brass; Finishing methods including buffing, plating etc.

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## Contact Details

This documentation for the course was done by Professor Ravi Mokashi Punekar, faculty at [DoD, IIT Guwahati](#).

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You can write to the following address regarding suggestions and clarifications:

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