THREE-DIMENSIONAL VISUAL ANALYSIS

DEPARTMENT OF INDUSTRIAL DESIGN
UNIVERSITY COLLEGE OF ARTS, CRAFTS AND DESIGN

INSTITUTIONEN FÖR INDUSTRIDESIGN
KONSTFACK

CHERYL AKNER-KOLER
Correspondence
I hope this book is constructively criticized with respect for Rowena Reed’s intentions and that suggestions for improvement will come my way.

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To Gunnar, Corina and Malcolm
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KONSTFACK
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"It is not exactly the presence of a thing but rather the absence of it that becomes the cause and impulse for creative motivation"  

*Alexander Archipenko*
This book aims to strengthen an understanding of the sculptural possibilities of form and space through developing a visual language and structure that recognizes and gives priority to 3-dimensional visual perception. It is written so as to apply to both the active process of shaping 3-D form and space and analyzing any existing visual situation.

Foundation
The foundation of this language is derived from the inspiring courses conducted by professor Rowena Reed at Pratt Institute in New York City and also in private Soho classes. Rowena Reed’s method of visual analysis taught her students to “think with their eyes” and to translate an inner vision into concrete experiences. Her challenging way of teaching combined creative exploration with an analytical search for the “Principles of visual relationships”.

The last pages of this book are dedicated to summarizing her background, philosophy and educational vision. Moreover, in order to gain a historical perspective, a map is included that outlines the relevant art movements in the beginning of this century and some of the major events in the early work of Rowena Reed and her husband Alexander Kostellow. As illustrated in this map, the Russian constructivist movement is the point of origin for the artistic tendencies and formal language developed by Reed and Kostellow.

Teaching in Sweden
Under the leadership of Professor Lars Lallerstedt at the Department of Industrial Design (ID) at the University College of Arts Crafts and Design (Konstfack) in Stockholm Sweden, I have been given great opportunities to further develop and document this visual study program. The visual problems taken on by the first and second year Industrial Design students provide the substance of this book. Using clay and paper models the students creatively question the “established terminology” and develop solutions which strengthen and / or add new concepts to the program. Regrettably, this interactive exchange of ideas with the ID students as they strive to bring visual thoughts into the 3-dimensional world could not be communicated within the scope of this book.

Although this book is written in English, most of my teaching has been in Swedish and therefore many ideas have been discovered and discussed in the Swedish language. This culturally imposed struggle with translating the visual language into Swedish and then using both English and Swedish to further develop the terminology has proven to be a very vitalizing process. To constantly re-examine the concept upheld by a term has made me keenly aware of the shortcomings of both languages. This inherent problem in communication has helped me see the need to create strong “visual images” of each form and space concept logically connected within an overall framework.
Framework
Through working and teaching within this constructivistic tradition I have felt the need to document and organize this visual 3-dimensional (3-D) terminology into a comprehensive framework which demonstrates the strength of visual analysis. The following four sections (I - IV) constitute the backbone of my teaching as well as outline the content of this book:

I. Elements and their properties
II. Movements and forces
III. Relationships
IV. Organization

Within this framework there are several underlying principles that are central for this 3-dimensional visual approach: 1) recognizing an interdependence between form, movement and space; 2) visualizing the inner movement and structure of form; 3) prioritizing asymmetry; 4) deconstructing a composition in a logical sequence from inner structure → movement → volume → plane → line → point; 5) perceiving 3-D compositions from a number of different views in order to grasp their all-roundness.

Intent
My intent with writing this book is to prepare the reader for a dialogue with the 3-dimensional world. I believe that deeper concern for our 3-D visual reality may be awakened through learning to discern form and spatial qualities in our environment. It is my hope that the methodology outlined in the pages of this book will give a starting point for discerning the different levels of complexity inherent in each visual situation and that general principles can be made concrete through each individual work. The concepts presented here can all be greatly expanded upon since each visual situation in itself is unique and demonstrates specific relationships which challenge abstract definitions.

I have tried to emphasize volume, inner movement, depth, space and all-roundness as much as possible in order to stress 3-D thinking. However, there is no way to simulate these qualities in 2-D illustrations and photos. As a result the characteristics of the outer configuration of the positive forms override the less tangible, spatial and volumetric qualities. Issues such as light-shadow, color, texture, transparency non-transparency, which are an intrinsic part of creating and experiencing form and space, have not been brought up here because of the limits of this documentational media and time. I hope to devote energy in the future to prepare and develop effective ways of documenting experiments which focus on these issues.

Methods of Documentation
This book is written on a Macintosh LC computer using Pagemaker® layout program. All photographic images show 3-D models made by ID students at Konstfack. The models have been photographed by a Canon ION digital camera and mounted into the computer using Macvision® software. The low resolution of the digital photographs was considered acceptable within the limits of the budget at the onset of the project in 1990. Some of the illustrations are created through Superpaint® program while others are derived from an Intergraph® CAD (computer aided design) system and then scanned into the computer. The CAD-technology made it possible to recreate some of the student’s geometrically derived 3-D models through a solid geometry computer program. This technique allowed us to deconstruct these models into their elemental parts.

The original material has been printed through a Hewlett-Packard Laserjet 4M printer.
This chapter on Elements and their properties deals with defining the basic visual elements and their elemental parts, dimensions and proportions. For the sake of simplicity, the cube and rectangular volume are used to exemplify principles and ideas in this chapter. The concepts here, however, apply to the entire spectrum of forms from geometric to organic and from positive to negative.

The primary geometric forms are described at the end of this chapter. The basic visual structure defined through these primary forms provides an important visual reference for the proceeding chapters.
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 is 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 defined as 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 is used to delineate the shape of a plane and the hard transitions between surfaces as they form the edges on 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. Point has no elemental parts and no dimensional movement, yet it expresses position.

Any 3-dimensional visual situation can be broken down into its different elements to gain an understanding of what the whole is made up of. The four basic elements are introduced in relation to the 3-D volume. Deconstructing the volume into its elemental parts stresses the importance of thinking 3-dimensionally even when working with 2-D or 1-D elements and, thus, focus on the 3-dimensional origin of visual elements.
Spacial enclosures can be considered basic visual elements of 3-dimensions if the positive elements limiting a space define a clearly recognizable shape. Negative elements are defined within the space between any of the positive elements: the surfaces on volumes or independent planes, lines and points in space. The description of the different positive elements can also be applied to the negative elements, yet perceived spacially. The elemental parts of spacial enclosures are, however, more varied than the positive elements.

The interaction between space and form represents a duality inherent in 3-dimensional visual analysis. It is what makes the visual world both concrete and abstract at the same time.

<table>
<thead>
<tr>
<th>POSITIVE ELEMENTS (FORM)</th>
<th>NEGATIVE ELEMENTS (SPACIAL ENCLOSURE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(+) VOLUME</td>
<td>(-) VOLUME</td>
</tr>
<tr>
<td>(+) PLANE</td>
<td>(-) PLANE</td>
</tr>
<tr>
<td>(+) LINE</td>
<td>(-) LINE</td>
</tr>
<tr>
<td>(+) POINT</td>
<td>(-) POINT</td>
</tr>
</tbody>
</table>

Fig. 2a

Fig. 2b

The definition of the elements: volume, plane, line, and point on the opposite page applies to tangible form (positive elements), yet the basic visual elements can also include spacial enclosures (negative elements).

Positive (+) and negative (-) elements (Fig. 2a-b) are similar in that they can both be described as visual components with more or less defined boundaries. A positive element - form - can not be perceived unless it exists in a spacial context, just as a negative element - spacial enclosure - can not exist without form to define its boundaries. The interaction between space and form represents a duality inherent in 3-dimensional visual analysis. It is what makes the visual world both concrete and abstract at the same time.

Spacial enclosures can be considered basic visual elements of 3-dimensions if the positive elements limiting a space define a clearly recognizable shape. Negative elements are defined within the space between any of the positive elements: the surfaces on volumes or independent planes, lines and points in space. The description of the different positive elements can also be applied to the negative elements, yet perceived spacially.

The elemental parts of spacial enclosures are, however, more varied than the positive elements.

The sequence of (-) volumes in figure 2b illustrates this variation: the first volume is a closed volume using five planes to define its boundaries, the second is partially open, using three planes and the third is a open volume outlined by one plane and one line. The limits of spacial enclosures are dependent on the strength of spacial articulation of the surrounding positive forms. This involves perceiving movements and forces (see chapter II) and relationships (see chapter III) that are expressed from positive elements into space. Spacial elements can therefore be interpreted differently depending on the view-point of observation and the spacial awareness and experience of the observers. The concept of negative elements is more difficult to comprehend and perceive than positive elements because we are trained to see and discern objects rather than the space between them.
There are a number of different terms that are used when referring to the dimensions of elements: length, height, width, breadth, depth, thickness etc. Some of these terms imply a spacial orientation. Height implies a vertical direction in space starting from the base of an element and moving to the top. Width and breadth imply movement from side to side. Depth means the direction backwards or inwards. Thickness and length have no spacial correlation. Thickness is usually the smallest measurement of an element, whereas length refers to how long an element is and implies measurement. The less dimensions an element occupies, the less correlated the terms are to specific spacial orientation.

A volume has 3-dimensions:
- Height = 1-D
- Width = 2-D
- Depth = 3-D

A plane has 2-dimensions:
- Length or Height = 2-D
- Length or Width = 2-D

A line has 1-dimension:
- Length = 1-D

A point has 0-dimensions:
- Position = 0-D

In theory, the concept of independent 2-D planes having only length and width can not exist in a 3-D world. Yet, they are part of our visual vocabulary used to describe a figure whose predominant visual qualities expresses 2-D. The definitions have been abstracted in order to use the idea of plane, line and point in a 3-dimensional visual context. When referring to planes in space you disregard the thickness of the material that the plane is made of, as implying an articulation of the third dimension. Thickness of a plane is seen as a visual detail subordinate to the two predominant dimensions of a plane. A similar explanation is applied to line and point.

The limits of the first and second dimension. There is an inherent problem in defining 1- and 2-dimensional elements as independent elements in space, because of the added thickness of the material the element is made up of.

Fig. 3
Inherent proportions involve the direct correlation of one elemental part to another. For example, the measurements of the length and width of a plane determine the exact length of the lines which border it. If the proportions of the plane are changed, then the length of the lines will be altered in correspondence to the plane.

A cube uses the elemental parts (Fig. 4): planes, lines and points to limit its total mass and to delineate and punctuate the transitions between surfaces. All the six square planes on the cube are identical in size and all the lines on the planes are therefore the same length.

Geometric forms are strictly bound by the laws of geometry. Figure 5 shows that the change of the width of plane 1 directly affects the proportions of three other planes including their edges (lines) as well as the relative inherent proportions of the entire volume. The concept of inherent proportions also applies to organic form, however, the elemental parts are not as interdependant as geometric forms. It is possible to change the shape of a plane on one side of an organic volume and not affect the proportions of the entire volume.
The concept of General Proportions summarizes the essential proportional features of an element rather than gives an exact elemental description. The three primary proportions a form can assume involves the following features:

**Extensional** - expresses length.
   A line illustrates the most extreme expression of extension.

**Superficial** - expresses flatness.
   A square plane is the most extreme example of superficial proportions.

**Massive** - expresses volume.
   A cube is the most extreme example of massive proportions having no extensional or superficial qualities.

**General Proportions Circle**

The primary proportions (shown in black in figure 6) are extensional, superficial, and massive. Three secondary proportions (shown in grey in figure 6) combine 50% of two primary proportions: extensional / superficial (E/S), superficial / massive (S/M) and massive / extensional (M/E). The middle volume (shown in white) is a combination of all three primary proportions: extensional, superficial, and massive (E/S/M).
To see the complete visual make-up of the 3-D elements and their properties is a spacial- as well as a form-experience. It is of equal importance to be aware of the variation of proportions of each solid volume as the model turns, as well as the fluctuating spacial proportions between the volumes.

By seeing the model from different views visual information can be obtained to judge the dimensions and general proportions of each volume.

The study model of “Three Rectangular Volumes” in space shown from three different view-points in figures 8-10 is the first exercise in this visual program. It applies the visual structure and vocabulary introduced in this chapter as well as some of the principles in chapters 2-4.

In figure 10 the horizontal extension of each positive (a, b, c) and negative (d) volume is marked by a line (black or white) in order to illustrate the contrast in measurement between the planes on the different positive and negative volumes from this view. Throughout the entire composition there is as little repetition of measurement as possible.
The three families of curved primary geometric volumes are:

**Ellipsoid sphere**

**Cylinder**

**Cone**

The basic curved primary geometric volumes are illustrated on the first horizontal row in figure 13 (dark grey background). These three massive volumes all have equal parameters for height and diameter. The other volumes in the same figure show how primary volumes can vary in general proportions: massive-extentional-superficial. Geometric planes can be derived from all these primary geometric volumes by cutting them in three sections oriented horizontally, vertically and in depth (Fig. 11). Figure 12 summaries the various geometric planes resulting from these three sections. The planes derived from the ellipsoid family are circles/ellipses, planes from the cylindrical family are circles/ellipses and squares/rectangles and planes form the conical family are circles/ellipses and triangles.

**Three sections of the volumes:**

<table>
<thead>
<tr>
<th>Cone Section</th>
</tr>
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<tbody>
<tr>
<td>Circle</td>
</tr>
<tr>
<td>Sphere</td>
</tr>
<tr>
<td>Triangle</td>
</tr>
</tbody>
</table>

**GEOMETRIC PLANES**

<table>
<thead>
<tr>
<th>Cone Section</th>
<th>Circle</th>
<th>Sphere</th>
<th>Triangle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circle</td>
<td>Circle</td>
<td>Circle</td>
<td>Circle</td>
</tr>
<tr>
<td>Sphere</td>
<td>Sphere</td>
<td>Sphere</td>
<td>Sphere</td>
</tr>
<tr>
<td>Triangle</td>
<td>Triangle</td>
<td>Triangle</td>
<td>Triangle</td>
</tr>
</tbody>
</table>

**Fig. 11**

**Fig. 12**

**Fig. 13**
The four families of straight primary geometric volumes are:

- **Rectangular volumes/cube**
- **Triangular prism**
- **Pyramid**
- **Tetrahedron**

The basic straight primary geometric volumes are illustrated on the first horizontal row in figure 14 (dark grey background). The first four massive volumes all have equal parameters for height and base. The other volumes in the same figure show how these primary volumes can vary in general proportions: massive - extensional - superficial. These volumes have also been cut horizontally, vertically and in depth as illustrated in figure 11.

The planes derived from the rectangular volumes family are squares/rectangles, planes from the triangular prism family and the pyramid family are triangles and squares/rectangles and planes from the tetrahedron family are regular or irregular triangles. Figure 15 summarizes the cut planes from figure 14.

<table>
<thead>
<tr>
<th>GEOMETRIC PLANES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Square/Rectangle</td>
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<tr>
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</table>
## Description of 7 PRIMARY GEOMETRIC FORM FAMILIES

<table>
<thead>
<tr>
<th>ELLIPSOID / SPHERE</th>
<th>CYLINDER</th>
<th>CONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A sphere is classified within the ellipsoid geometric family, yet it has special conditions which govern its structure. The sphere is usually the simplest form because it is perfectly symmetrical from all views. The single continuous surface that covers the volume is a double curved surface which is at an equal distance from the center creating circular contours and no articulated axes. Ellipsoids, like the sphere, are defined by one continuous double curved surface, but the distance from the center gradually changes through elliptical curvatures. An ellipsoid can change its proportions along one, two or three axes, but the sphere can only change in size.</td>
<td>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 a 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 neutral (circular) simple curved surface to an accented elliptically curved surface. The outline of the two base surfaces then change from circular to elliptical.</td>
<td>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 a 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 surface creates the 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.</td>
</tr>
</tbody>
</table>
A pyramid has similar features as the cone, such as the diagonal contour of the form and the vertex point at the top. The elemental parts of a pyramid are four planes with triangular outlines and a fifth plane which is square or rectangular. The triangular planes meet at a vertex at the top and form the sides of the pyramid. The square or rectangular plane forms the base. The straight pyramid with the tip of the pyramid in line with the center of a the base implies that the opposing triangular planes are identical. Proportional changes are determined by the rectangular proportions of the base and the height of the vertex.

A triangular prism is similar to a cylinder in that it is symmetrical between the two parallel triangular planes and out from the primary axis. The elemental parts include three rectangular or square planes and two parallel triangular planes. The three rectangular or square planes are at an acute or obtuse angled 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 triangular end planes involves no structural changes in the angles between the elements. However, changing 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.

A cube is defined by the same properties as a rectangular volume, however, it has special conditions governing its proportions. The cube is visually the simplest straight geometric volume, because its elemental parts are all identical and the composition of the elements involve right angles and parallel relationships. The 6 flat elemental planes of the cube are all squares of equal size, which fixes the inherent proportions and allows no variation in width, depth or height. The only changes that can occur are in scale. A rectangular volume is constructed of 6 flat rectangular or square planes in right angled relationships to the bordering planes. There are three sets of parallel planes which have an inherent proportional relationship to each other. Variations of the proportions of a rectangular volume can occur along all three axes.

The tetrahedron is the simplest 3-D closed volume that can be constructed of flat planes, just as the triangle is the simplest 2-D plane made of straight lines. The tetrahedron is also the most structurally stable form of all the 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 of four identical equilateral triangular flat planes and has structural similarities with the cube. Proportional changes are made by varying the angular relationship between bordering surfaces which directly changes the degree of each angle on the triangle as well as the length of the sides of the triangular planes.
The first step in analyzing a concrete 3-D composition is to perceive the inner- and spacial activity of the elements. These "activities" encompass the combined effect of movements and forces. The movement of an axis and the forces that act upon it, can only be indirectly perceived through the visual clues from positive forms. It requires a kind of "x-ray vision" which visualizes the paths of visual energy that interacts with the proportions and shapes of the elemental parts.

The nature of sculptural experiences are rooted in the perception of the energy and inner structure of a form or composition. The general path of movement through major proportions of the positive and negative elements governs the surface/plane activity. The transitions between surfaces in turn control the position, shape and sharpness of the edges (lines) as surfaces come together on the form. The position of corners/points are the last visual details of sculptural articulation.
**AXIS**

The general definition of an axis is an imaginary line within an element which is the fundamental structure that all elemental parts refer to (Fig. 16).

1. **Primary axis** - the central structural line in an element which expresses the major movement of the form. It is also often the longest axis within the form.

2. **Secondary axis** - lies in oppositional angle to the primary axis and gives a structural line that represents the movement outward from the primary axis. It is often the second longest axis within the form.

3. **Tertiary axis** - the structural movement that is subordinate to the primary and secondary axes. It is the shortest axis and usually expresses less movement than the other two.

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**AXIAL MOVEMENT**

The movement of an axis can only be indirectly perceived through the visual clues from positive forms. It requires a kind of "x-ray vision" in the mind’s eye which visualizes the paths in inner activities that interacts with the proportions and shapes of the elemental parts.

**INNER AXIAL MOVEMENT** is the motion expressed **WITHIN** the form (Fig. 17), through the length of the primary axis. The movement can range from a simple straight axis to a compound curved axis.

The axial movement also continues **BEYOND** the form / spacial enclosure. This **CONTINUAL AXIAL MOVEMENT** activates the space that follows in line directly after the axial movement of the form (Fig. 18). The continual visual movement of the elements strengthen the articulation of a dimension in space as well as allows for potential relationships to arise between forms across space.

**DIRECTIONAL MOVEMENT** is the general direction in which the whole form moves. A rectangle has no specific directional movement along its primary axis, but it can gain direction.

---

**Fig. 16**

**Fig. 17**

**Fig. 18**

**Fig. 19**
Elements with straight axes have a uniform inner movement that is often reflected in outer symmetrical shape and restricted spacial activity. Forces can be introduced to increase visual complexity both within and beyond an element.

A force(s) can induce structural asymmetry which is expressed in bending or curving the inner axis of a form and some of its elemental parts. Forces themselves can not be seen, but may be perceived by how they affect positive forms. The energy from the force is absorbed by the positive element and then projected outward through the form and into space. The force-induced changes in form are the results of the power the force has over the integrity and strength of the elements.

Forces encompass the following features:

**STRENGTH**
- weak
- strong

**SCOPE**
- focused
- spread

**ANGLE TO AXIS**

An axis can express three general conditions:

A straight axis (Fig. 21a) involves a 1-dimensional movement, without any forces acting upon it.

A bent axis (Fig. 21b) incorporates two activities from different dimensions: the movement of the axis and the force that abruptly changes the course of the axial movement creating a sharp bent angle.

A curved axis (Fig. 21c) can express two or more activities from different dimensions: the axial movement and the force(s) that gradually change the course of the axis.

**Curves**

A curve is a smooth and continual change in direction (Fig. 22 and curve chart on p. 20).

The three ex. of curved planes/surfaces in figure 22 illustrate the correlation between the axial movement & the shape of the edges/transitions of each surface.

The original rectangular plane is changed to a simple curved plane. The two curved edges (x and y) express the same curve as the curve of the axis (z). The two end-edges remain straight.

This view of a merged volume (p. 39) shows a twisted plane (B). The two curved edges (x and y) and the primary axis (z) are similar, yet each express a slightly different curve. The two end-edges remain straight.

The compound curved surface (C) curves in all 3 dimensions. The edge (x) and transitional surfaces (y) all express different curves that respond to axis (z) as well as the movement of the surrounding surfaces.
The chart in figure 25 shows examples of a variety of different curves. The purpose of this chart is to offer a selection of curves which illustrate subtle differences in how the curve expands, due to the strength, scope and angle of each force(s) (see Fig. 20). The shape of a curve can assume two general features: neutral or accented (Fig. 23-24). Three of the curves on the chart are neutral: circular segment, spiral and reverse (even) and the remaining curves are accented.

**Neural:*** The curve has the same radius throughout the entire curvature. A segment of a circle is neutral.

**Accent:*** The degree of curvature changes throughout the curve. The accent is the most expanded area of the curve.
Figures 28 and 29 are fragments of the divided ellipsoid (see chapter III).

Figure 28 (fragment 1) shows the straight silhouette of one of the simple curved dividing surfaces through the ellipsoid and also the accented surface on the outer contour of the ellipsoid. The movement of the axis is a compromise between the straight silhouette and the accented surface.

The curved surface (a) in figure 29 (fragment 2) shows a neutral curve that comes from the circular contour of the ellipsoid. Surface (b) is a simple curved surface that divides the ellipsoid. Directional forces radiate from the accent on surface (b) through the form and out into space.

Directional forces add visual activity to the composition that can compete with the inner axial movement of the elements. The organization of the elements should include coordinating the axial movement and position with the directional forces. The concept of balance (see chapter IV) relies greatly on how the directional forces work to complement the other movements and structures within the composition.
Relationships are created between the properties of the elements (chapter I) and their movements and forces (chapter II). These interrelationships create a network of visual connections that make up the overall visual statement. Each relationship, no matter how subtle, becomes an important compositional link so that even the smallest detail can influence the originality and quality of the entire visual image.

This chapter on relationships also includes ideas of how to combine and reshape geometric forms based on principles of division, adaption, distortion etc. These ideas are presented under their own section called "Transitional forms". Following this section is an introduction to structural principles and interrelationships of forces concerning organic forms. A chart over the different geometrically derived forms and organically shaped forms is presented at the end of this chapter. The theme of this chart is to illustrate an "Evolution of Form" from geometric to organic. The sequence of "evolution" shows two different 3-D models that exemplify two ends of a spectrum at each stage.
The idea of hierarchy of order is implicit when working within an asymmetrical organization. Since the principles of asymmetry prioritize contrasting properties and non-repetition, there will always be elements and qualities that dominate and others that are subordinate (Fig. 30).

A method for deciding which visual qualities/forms are more important than others is to first cover up or “think away” one quality/form at a time (Fig. 31-33) and ask the following questions:

Which form seems to give the entire composition its identity? Which is the most visible from all views and is perhaps largest? This is the dominant. Which one has a clear and vital interrelationship with the dominant, yet has a less interesting shape and is smaller? This is the subdominant. Which is dependent on the dominant and subdominant forms, yet is smaller in size and is a complementary form? This is the subordinate.

### ORDER

<table>
<thead>
<tr>
<th>The features that determine the hierarchy of order in compositions are:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dominant</strong> -</td>
</tr>
<tr>
<td>character - strongest</td>
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<tr>
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<td><strong>Subdominant</strong> -</td>
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<tr>
<td>character - strong</td>
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<td>size - smaller than Dominant</td>
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<td><strong>Subordinate</strong> -</td>
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<td>character - complementary to dominant and subdominant</td>
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<td>size - smallest</td>
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<td>spacial articulation</td>
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<td>dependent on the dominant and subdominant</td>
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- The character is strongest among all forms.
- The size is the largest among all forms.
- The interesting position is more pronounced among all forms.
- The spatial articulation is distinct among all forms.
- The structural importance is more significant among all forms.
- The influence over other parts is the most evident among all forms.

Fig. 30

Fig. 31

Fig. 32
ORDER cont.

The idea that something dominates over another can be relative to the view of observation. At some viewpoint a subordinate form can gain more visual attention because it is closer to the observer or partially overlaps a more dominant form as in figures 34a and 34b.

However, certain features and forms will be remembered as having overall dominance. This accumulated allround impression, which our visual memory and 3-D experiences are built on, gives the basis for judgement of the work and a sense of order can be interpreted.

GROUPING

Each level of the hierarchy can be represented by a single positive (Fig. 30) or negative element (Fig. 36) or by a group of elements. Grouping elements or features together involves recognizing similarities, e.g.: shape, movement, position, size, proportion, color.

Figure 35 shows that the forms a & b are identical in shape, movement and proportion (but not orientation). Together they form a group which has a subdominant roll in the composition. The relationship between grouped elements/features can occur in a specific area or across the entire composition. The shared qualities that define a group must have visual strengths that overrides other form/space interruptions.

The idea of order is easy to understand when it comes to the example above and on the prior page, since each form is a separate unit. When analyzing a complex object that is highly differentiated and does not easily break down into separate units, it is more difficult to specify what the visual order is. None the less, it is important to seek a visual hierarchy to gain an awareness as to which features are essential in communicating the visual message.

Throughout the development of a composition, experimental studies can be undertaken to see if the message can be made stronger. The non-essential features can therefore be reshaped in order to reinforce the major idea.
Since the axes represent the individual visual structure within each element, then axial relationships created within and between elements reveal the essential framework of the composition. Some basic axial relationships are:

Oppositional Relationships - The axial movement of one element lies in an opposite dimension to another. The forms pull away from each other, moving out in different dimensions and are considered independent visual components. Figure 37 shows oppositional relationships: adjacent and across space.

Parallel Relationships - The axial movement of one element runs parallel to that of another. Figure 38 shows parallel relationships: adjacent and across space. Figure 35 on the prior page shows a parallel axial relationship across space between (a) & (b) which also forms a group.

Continual Relationships - The axial movement of one element flows directly into another. Figure 39 shows two continual relationships: adjacent and across space.

**Gesture**

A gesture is a special condition for curved elements in a continual relationship. It deals with guiding the axial movement of forms so they gradually group together to make a continual complex movement.

The change in position, direction and distance between each line in figure 40 depends on the shape and strength of the continual movement (see page 18) from one to the next. If the gesture involves 3-D volumes, then the proportions and outer shape should complement each other so that some of the contours of the forms continue from one to another.
In figure 41a, a black circular plane and a black rectangular plane are compared to each other and to the surrounding outlining frame. Together they visually activate the space within the frame. The circle is lifted slightly from the bottom line of the frame activating the space underneath. The rectangle and the circle express contrasting comparative relationships between the roundness of the circle and the straightness of the rectangle.

The frame itself has a primary vertical movement, which reinforces the vertical movement of the black rectangle. The solitary circle in figure 41b loses some of its contextual identity since it is isolated from other elements. Its roundness is no longer compared to the long rectangular qualities of the other plane and without the frame its position and scale seems vague.

Figure 42 shows a cube divided by a simple neutral curved surface that cuts through the cube in two opposing directions. This model demonstrates several comparative relationships, e.g. between the negative and positive parts, between the curved surface and the straight edge / right angled corners.
JOINED FORMS

Joining elements together provides a structural quality between the elements. The relative proportions and the 3-D orientation of each volume determines the type of joint, i.e. orientation in the vertical, horizontal and depth dimension, as shown in figure 43.

Vertical dimension | Horizontal dimension
------- | -------
Front view: | 
Top view: | 
Depth dimension |

Fig. 43

There are three basic joints that can occur between rectangular volumes in a static organisation (see chapter IV): "L" = 2-sided, "U" = 3-sided, "O" = 4-sided

1 2 1 2

The above three joints can be made as PARTIAL or COMPLETE joints as illustrated in figure 44.

ACTIVE and PASSIVE: When forms are joined together there is usually an active form, that retains its entire volume and a passive form that is cut to make the joint.

Fig. 44
The composition in figures 45 - 46 is made up of an ellipsoid and two cylinders. The two joints applied here are both complete "U" joints.

The following features are added to the volumes due to the joints:

* elliptical curved lines around the joints
* induced axial movement through the flat cylinder between the two joints

The following features are subtracted from the volumes due to the joints:

* the elliptical cylinder (active) cuts into the flat circular cylinder (passive) - joint 1.
* the flat cylinder (active) cuts into the ellipsoid (passive) - joint 2

Since the volumes intersect each other at dynamic angles the two joints are asymmetrical.

From the accent of joint 2 an axial movement is induced through the surface of the flat cylinder upward toward joint 1.

In joint 2 (Fig. 46c) the passive ellipsoid is joined to the "active" flat cylinder on "three sides" creating a "U"-joint. A section of the "passive" ellipsoid is cut away to construct the joint. The elliptical hard edges introduced through joint 2 adds strong details to the composition.
Joining volumes together so that all three or more volumes intersect each other builds a compound joint. The three geometric rectangular volumes in figure 47 have oppositional relationships to each other that lock the volumes into place. There are two different types of joints applied here, "O" and "U", illustrated in figure 48. The new parameters introduced through the joints create asymmetrical qualities on the volumes. The orientation of the joints subdivide the rectangular volumes and introduces new edges.

Analysis of a compound joint
The brake-down of the compound joined volumes illustrates three joints (Fig. 48): The first is a complete "U"-joint showing the massive volume deeply joined on three sides within the superficial volume; the second is an "O"-joint where the extensional volume moves completely through the massive volume; the third is another complete "U"-joint showing the extensional volume cutting down the superficial volume.
The concept of intersectional forms is by definition restricted to the joints between basic geometric volumes. The surfaces that “cut out” the intersectional forms are therefore completely geometrical.

None of these cut-surfaces on the intersectional forms can be seen on the exterior of the joined volumes. The intersectional forms therefore must be derived indirectly from the different inherent proportions and structure of each of the volumes. The hard lines at the joints between the volumes define some of the contours/edges of the intersectional forms (see Fig. 49-50). Yet, to visualize the proportions and contours of the compound intersectional form(s) takes a great deal of concentration, because the properties of the joined geometric volumes influence your visual interpretation of the intersectional form.
The two joined volumes in figure 51 are illustrated with different values of gray to separate the volumes from each other and to easily identify the origin of the cutting surfaces that define the intersectional form. The cylinder is light gray and the sphere is dark. Correlating these gray surfaces to the core form shows that the spherical surface (dark gray) defines the top surface and the cylindrical mantle surface (light gray) defines the bottom surface.

Another example of two joined curved volumes is shown in figure 52a. The composition is that of a cylinder piercing through a cone; the corresponding intersectional form is shown in figure 52b.

Figure 52c shows an intersectional core form derived from a joint between a cone and a sphere.
This separate section on transitional forms within chapter III describes how geometric volumes can be altered through introducing new form relationships between elemental parts, forms or forces. The concepts divide, adapt, merge and distort (presented in the following pages) are grouped together under the heading transitional forms. By using primary geometric volumes as a starting point for development, new features which deviate from geometry can evolve.

The form exercises based on the above concepts are developed to explore transitional properties and are conducted under visually controlled conditions which help to isolate the specific qualities in question. It is the resulting variation in shape that is the focus of interest in this section as well as finding ways to communicate the new “transitional properties” that arise.

The method used to structure the transitional properties that each solution embodies, is to set up a bipolar spectrum that marks out two extreme qualities. As an example, divided forms (p. 34) are related to each other in a spectrum from accordance (features that are similar to the original form) to discordance (features that are different from the original form). Some of the transitional form concepts were easier to analyze by this spectral method than others. Nevertheless, there is a great deal of visual experience to be won in the process of defining the general theme for the spectrum as well as the extreme situation that exemplify each spectral end.
To **DIVIDE** means to cut through a geometric form creating two or more parts. The relationship of parts to the whole and the direct correlation between shared cut surfaces gives an inherent logic and visual order to divided forms.

The 3-D movement of the dividing surface(s) and its orientation through the form can introduce unique qualities to the parts that can be similar or different to the original form. The shape and size of these parts are confined within the properties and proportions of the original geometric form.

The visual analysis here deals with the similarities and differences between the properties of the original geometric form and:

- the dividing surface(s)
- the inherent proportions and shape of the parts
- the overall organization of the parts

When the above features are similar to the original form they are in **accordance**.

When the above features are different from the original form they are in **discordance**.

The sequence illustrated in figure 53 of divided rectangular volumes, is based on the movement and orientation of the dividing surface. The dividing surface gradually changes from straight to compound curved and from a vertical to diagonal/curved orientation. The first volume to the left has been cut into two parts by a straight surface moving perpendicular through the volume (a). The new cut planes/surfaces that appear on the two parts are identical to each other and to the end planes on the original volume. These two planes are therefore both in total accordance. Progressing through the sequence from left to right, the straight surface first changes orientation. By tipping the surface at a diagonal, angled in one dimension, the two cut planes retain a rectangular shape (b).

The next change in orientation is tilting the plane dynamically backwards, angling the plane in two dimensions (c). None of the corners are right angled and thus, the cut planes have become rhomboids. Since all these planes are flat with straight edges they are more or less in accordance with the planes on the original volume. The next step in the sequence is that the surface movement changes from flat to simple curved (d). This curved movement introduces features that are not derived from the original rectangular volume. The curved cutting surface becomes more complex changing from mono-axial (simple curved) to tri-axial curved as it moves to the right. The last three divided volumes (d-f) express varying degrees of discordance.
Figures 54 - 57 show the division and reassembly of a sphere. The organizational concept for this model is based on 3 flat dividing surfaces that cut through the sphere. The cuts are made in a specific sequence (Fig. 55) which are followed by shifting or rotating the parts on the dividing surfaces.

Sliding this part on the common cut planes creates a crescent shaped plane.

The contrasting sharp corners and straight lines shown here are mostly hidden within the composition.

The spherical like quality of the original form is retained.

**DIVIDED FORMS** applied to sphere

The following features are in **Accordance**; similar to the original form:

- circular contour on the flat cut planes
- crescent shaped planes
- retaining the spherical-like quality in the overall gestalt
- sliding and/or rotating the parts on the cut planes

The following features are in **Discordance**; different from the original form:

- flatness of the dividing surface
- straight lines and sharp corners that appear at the intersection of two cutting surfaces
ADAPT

To **ADAPT** means to fit one geometric form up against or around another geometric form without subtracting or reducing either of the forms. In the process of adaptation one form is defined as stable (unchanged) and the other, the compliant (pliable or changed). The compliant form is reshaped at the area of contact to comply with the properties of the stable form. The edges of the adapted (compliant) form are hard so that there is a clear border line between the forms. The visual analysis here starts with examining the:

- orientation of the forms to each other
- elemental parts of the compliant form to find a starting point for adaption

There should be a sense of control over the adapted area on the compliant form so that it seems consciously manipulated to fit the stable form, instead of forced or deformed.

Figure 58 defines the two extremes within the spectrum for adaption, e.g. **ASSIMILATE**: to adjust the compliant form so as to encompass the stable form and **DISSIMILATE**: to disengage or segregate the compliant form from the stable form.

The method of adapting the compliant form to the stable form can be separated into two types: To manipulate the entire compliant form around the stable form (a) or to make an incision in the compliant form at the edges of the elemental parts of the volume or in a “visually logical” area (b).

Adaption of one form to another involves developing features that are similar to joined forms (p. 28-30). Joined forms have a defined border between the forms at the joined area, just as the compliant form retains a distinct border as it adapts to the stable form. Joined forms express passive and active qualities within the joint, which can be compared to the compliant and stable qualities of adapted forms. The adaption of the compliant form also expresses control-led distortion based on the shape of the stable geometric form.
Figures 59a-c show different views of an elliptical cylinder adapted to a cube. The elliptical cylinder is compliant and the cube is stable. The sharp edges and corners of the cube have cut through one of the flat elliptical surfaces and the simple curved mantle surface. The volume of the cylinder has been adapted to the shape of the cube by creating distorted corners (Fig 59b) on the cylindrical volume.

The organization of the two volumes is dynamic (see chapter IV) and the adaption involves one of the accented areas of the elliptical cylinder (Fig. 59a-c) and four hard edges of the cube.

The simple curved mantle surface is divided and pressed outward to partially encompass the massive body of the cube. Two hard edges are introduced on the mantle surface as well as two non-geometric double curved surfaces (Fig. 59b-c).

The following features are **Assimilated**: involved in complying to the stable form:

- four straight edges on elliptical cylinder induced by the cube
- non-geometric double curved and simple curved surfaces
- the outer elliptical edge stretches to accommodate for the cube
- distorted corners introduced on the cylinder
- asymmetrical qualities on the original symmetrical cylinder

The following features are **Dissimilated**: uninvolved in complying to the stable form:

- more than half of the elliptical cylinder is unchanged
- main straight axis in the cylinder is intact
- the top elliptical surface retained its original geometric properties
- the shape of the cube is easily discernible
MERGE

To MERGE means to blend two or more geometric forms into a combined figure. Merging of forms can occur gradually throughout the entire composition or abruptly within an isolated area where the two forms come together. The overall figure can appear to unite or to separate the original forms depending on:

- orientation, movement & relationship of the axes of the original forms toward each other
- variation in properties, size and elemental parts between forms
- how gradual or abrupt the transition between surfaces are

Figure 60 defines the two extremes within the spectrum of merging forms: **Converge** involves unifying forms as well as creating transitional surfaces that gradually change from the properties of one form into the properties of another. **Diverge** involves separating forms as well as creating transitional surfaces that abruptly change from one form to another.

**CONVERGE**

Features that express unity between forms. The transitions are gradual.

- rectangular volume + triangular prism
- sphere + triangular prism
- pyramid + circular cone
- elliptical cone + tetrahedron

**DIVERGE**

Features that express separation between forms. The transitions are abrupt.

Figure 61 shows a sequence of four forms from converge to diverge. The order is determined in reference to the transitional surfaces and how gradual or abrupt these surfaces merge the forms together. If the sequence was based on showing unity - separation, then form (b) would change places with form (c) since the overall proportion and contour of form (c) expresses a more unified merged form.

Figure 61 shows a merged forms that express some visual properties of a joined forms. Surface(s) on the triangular prism is not a transitional surface but rather a surface that cut into the ellipsoid. This shows an example of how the different form stages overlap with each other.
The following features
Converge; unity between forms gradual transitions
* The two original forms are totally united with each other
* The main straight axial movement in both volumes have merged together and express a single curved axis
* All of the surfaces parallel to the main axis of the original forms have merged together and transformed from straight to curved
* One of the 4-sided surfaces on the rectangular volume has been transformed into a 3-sided surface

The following features
Diverge; separation between forms abrupt transitions
* The top triangular surface from the triangular prism is unchanged
* The bottom rectangular surface from the rectangular volume is unchanged

**MERGED FORMS** applied to triangular prism and rectangular volume

Figures 62a-e show different views of a merged rectangular volume with a triangular prism. The original forms had similar size and proportions. The two forms were originally placed at a dynamic angle to each other. To compensate for the changes from a rectangular volume to a triangular surface, one of the edges of a rectangular surface must be reduced to a point (Fig. 62a).

The only two surfaces that are unchanged from the original geometric forms are the triangular surface shown in figure 62d and the rectangular base shown in figure 62e.

The rectangular surfaces on the sides of the volume stretches and curves to adjust to the transformation.

The original rectangular volume curves through its surfaces and inner axis to meet the edges of the dynamically oriented equilateral triangle.
To DISTORT means to expose a geometric form to a force(s) affecting its inner structure and elemental parts. The act of distorting can be a direct result of forces that affect the qualities and inherent properties of the material in which the forms are made, e.g., throwing a block of clay against the wall. Another way is to interpret how a force should affect a form under controlled conditions, given a defined material. This method of distorting is on a more abstract level since the materials used to make the model can differ from the intended material. Some different direct, physical forces are: twist, squeeze, roll, pull, push, bend, hit, erode, etc. Examples of interpreted forces are: optical distortion, implosion, explosion etc.

Figure 63 shows different ways of distorting geometric forms within a spectrum. The position of each form within the spectrum shown here is relative and not absolute. On the one end of the spectrum is conform, the form expands the inner mass which stretches the surfaces. Conform also means that force(s) work with the properties of the elemental parts and the inner structure of the original form. On the other end is deform, the form contracts and the force(s) work against the properties of the elemental parts and the inner structure of the original form.

Figure 63 a-c shows different extremes in form within the spectrum. The properties of the surfaces on all the forms have been more or less changed as well as the edges and contours. Distorted forms often express tensional relationships between expanded and contracted areas. The visual changes that occur on distorted geometric forms are often of an organic nature, i.e. transitional surfaces, expansion and contraction, convexities and concavities etc. (see Chapter IV).
DISTORT means to expose a geometric form to a force(s) affecting its inner structure and elemental parts. The act of distorting can be a direct result of forces that affect the qualities and inherent properties of the material in which the forms are made, e.g., throwing a block of clay against the wall. Another way is to interpret how a force should affect a form under controlled conditions, given a defined material. This method of distorting is on a more abstract level since the materials used to make the model can differ from the intended material. Some different direct, physical forces are: twist, squeeze, roll, pull, push, bend, hit, erode, etc. Examples of interpreted forces are: optical distortion, implosion, explosion, etc.

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The position of the above selected forms within the spectrum (Fig. 63 a-c) is based on expansion and contraction. The properties of the surfaces on all the forms have been more or less changed as well as the edges and contours. Distorted forms often express tensional relationships between expanded and contracted areas. The visual changes that occur on distorted geometric forms are often of an organic nature, i.e., transitional surfaces, expansion and contraction, convexities and concavities etc. (see Chapter IV). The way the force(s) work with or against the structure of a geometric form depends upon the:

- type
- movement
- magnitude
- orientation

DISTORTED FORMS applied to circular cylinder

By taking hold of the two ends of the original cylinder and twisting the form around its own axis (Fig. 64) the simple curved surfaces of the original form change to double curved surfaces with two strong asymmetrical accented areas (b and c in Fig. 65). This axial twist work with the structure of the original form. A tensional relationship between these two accents (Fig. 65) expands the form diagonally and changes the movement in the mass of the original cylinder. The grip used to hold the cylinder squeezed the circular ends and created oval, simple-curved surfaces (a in Fig. 64).

The form expands between the two accents

The overall proportion, structure and movement have expanded and the form no longer retains strict geometric properties, yet a geometric heritage can be deciphered. Figure 66 shows a straighter silhouette due to the more simple curved quality of the surface at the oval accents of the form.

The following features Conform; expand and work with the original form:
- The mass and mantel surfaces expand outward
- Twisting the cylinder around the primary axis
- The hard edges of the original circular ends of the cylinder are retained as they change to oval
- The more or less straight silhouette as seen in figure 66

The following features Deform; contract and work against the original form:
- Introducing double-curved surfaces with asymmetrical accents
- The end-surfaces contract inward and are simple-curved with oval contours
- The tensional relationship occurs through the mass, changing the movement of the axes within the form

The original form was a circular cylinder.
FORCES IN RELATIONSHIPS

Forces express visual activity within and beyond the positive and negative elements. As mentioned in chapter II, forces are not visible in themselves, however, their paths can be discerned and controlled through the shapes of the positive forms in the composition. The visible embodiment of a force can be seen at the accent of curved surfaces or at angled corners within and at the edges of volumes.

TENSIONAL RELATIONSHIPS deals with the energy that radiates from directional forces (Fig. 68).

The two illustrations below in (Fig. 69a-b) show two examples of tensional relationships. In figure 69a the directional forces on the concave side of the two curved lines channel their energy out from the accent towards each other.

Fig. 69a Fig. 69b

In figure 69b the force from the convex side of one curve relates to the force from the concave side of the other curve.

The distorted cylinder in figure 70 shows a tensional relationship through the mass. An inner energy and tension is embraced between the two accented areas, (a) and (b). The arrows represent the directional forces that channel this interaction. The tensional relationship moves at a diagonal through the form.

In figure 71 the rectangular volume is distorted (see p.40) through expanding inner forces. The accented compound curve at the top interacts with the front and with part of the underside of the volume. The axial movement of the form runs horizontally through the longest proportion and is affected by the organic (see p. 43) inner activity of the forces in tensional relationships.
A general definition of organic is to have properties associated with living organisms. The approach in this handbook for describing organic form is to find links from the organic world to the geometric world. Unlike geometric forms, which have a clearly defined mathematical structure that dictates and restricts the properties of the elemental parts, abstract organic forms are in general “amorphous”. However, the simplest organic form = the egg, and the simplest geometric form = the sphere/ellipsoid have a great deal in common (Fig. 72).

Organic concepts presented here do not involve the mapping of shapes and forms from nature, but rather aims to find abstract general principles of growth and diminishment. The interaction between movements and forces is the most essential concept in organic form. Through these subtle inner activities organic forms express expansion and contraction. The visual elemental parts of organic forms are curved surfaces that are either convex or concave with varying degrees of transitions between the surfaces.

Convexity: growth and expansion
Concavity: diminishment and contraction

All eggs exhibit total convexity and can be regarded as the visual evolutionary link between geometric and organic forms. Perfectly spherical eggs, such as fish eggs, are during certain stages of development identical with the geometric sphere. This implies that the geometric and the organic form world may be considered to have a “visual ancestral origin”. Eggs can also resemble different members in the ellipsoid family (chapter I). The classic hen’s egg is similar to an ellipsoid, however, it is asymmetrical from top to bottom. The bottom curvature in figure 72 takes on the shape of a sphere which slowly transforms to different degrees of elliptical curvature as it moves upwards.

The hen’s egg has rotational symmetry around its primary axis. This rotational symmetry is exemplified through the circular section of a plane that cuts at right angles to the primary axis. The different sections mapped out below illustrate the similarities and differences between a hen’s egg (Fig. 73a) and a geometric ellipsoid (Fig. 73b). The dark circle on the inside of the egg sections is the yolk. Since the yolk is perfectly spherical any flat section through it results in circles of different sizes.
The neutral curved line below in figure 74 gives a simple illustration of convexity and concavity. The curved line implies that convexity and concavity are the direct opposite of each other, where the convexity is the outside and the concavity is the inside of the same curve.

**convex**  
**concave**

**Fig. 74**

Convexity - form pushing outwards  
Concavity - space pushing inwards

3-D convexities and concavities are expressed as organically shaped positive and negative volumes and are much more complicated than a curved line. There is no direct match between the inner and outer shapes of convexities and concavities on volumes due to how the entire mass of the form interacts with the forces.

The organic form shown from four different views in figures 75 - 78 express various shapes of convexity and concavity. The organic features are non-geometric and therefore each convexity and concavity is made up of a number of different surfaces that define the limits of the positive or negative volumes (see "central concavity" in figure 75). Tensional relationships across the enclosed space of the central concavity can be seen between the accents (a) & (b). Tensional relationships between accent (a) within the concavity and through the form to accent (c) on the convexity can also be noted. The transitions between the active surfaces on the convexity and concavity are important visual expressions of the form. In figure 75 the convex surface (d) has a harder transitional edge on one side and a soft transitional surface on the other side.

**Hard transition** (f) separate the convex surface from the central concavity, whereas **soft transition** (e) blends the convex with the concave surfaces.

These three different views of the above sculpture show various qualities of convexities and concavities.

**Fig. 75**

Deep concavities (g) & (h)  
Broad expanding convexity (i)  
Complex curved convexity (j)

**Fig. 76**  
**Fig. 77**  
**Fig. 78**
The sculpture in figures 79a-e is made up of concavities and convexities and is similar to the model on the prior page, however, the concavity has a more dominant role in the composition. The larger and deeper the concavity pushes its way into the mass, the more it influences the inner structure and thereby develops a visual dominance. The positive volume is diminished while the negative concave volume grows. The model illustrated here is built around a piercing concavity, which is the most extreme example of concavities. A piercing concavity can be compared to a tunnel. The two openings of the tunnel allow light to move through the form and an integration of convex and concave surfaces from one side to another. The openings as well as the inner "tunnel" are composed of a vast number of oval/organic surfaces and contours that blend and intertwine with each other.

Figure 80 shows a simplified example of this blend of contours as they progress from one opening through the tunnel to the other opening.

CONCAVITY and CONVEXITY

These five views of the same model show the diversity of oval and organic shaped surfaces defining this compound concavo-convex form. In figures 79b-d the opening and the piercing concavity are illustrated by drawings.

The piercing concavity moves in depth through the organic form in figure 79b.

The directional movement of the ovalar opening is angled to the vertical in figure 79d.

Only a part of the piercing concavity can be seen in figure 79c.
The "evolutionary" progression of form begins with the outline of the structure of primary geometric forms. Each stage progresses from this geometric base to a higher level of visual complexity. The sequence illustrated in figure 81 depicts seven stages of evolutionary development where each stage has its own bipolar spectrum (e.g. the divided spectrum ranges from accordance and discordance) as defined earlier in this chapter. The figure shows one example from each side of each spectrum.

The first stage of evolution, shown at the far left in figure 81, begins with joining primary geometric forms together. Demarcated within the joints are intersectional forms which are completely defined by geometric surfaces, yet allow for asymmetry.

The four following stages, i.e. divided, adapted, merged and distorted can be considered transitional forms because they progressively introduce transitional properties of non-geometric and/or organic nature and link geometric forms with "amorphous" organic forms. The last stage in development is organic, which emphasizes non-symmetrical convexo-concave features and is defined as having no initial geometric structure.

The gradual stages of form "evolution"
The gradual stages of form "evolution" begins with the outline of the structure of primary geometric forms. Each stage progresses from this geometric base to a higher level of visual complexity. The sequence illustrated in figure 81 depicts seven stages of evolutionary development where each stage has its own bipolar spectrum (e.g. the divided spectrum ranges from accordance and discordance) as defined earlier in this chapter. The figure shows one example from each side of each spectrum.

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does not show all the different phases form can undergo. The aim is to find logical links that connects and overlaps one form spectrum with another.
In this section on organization ideas and principles will be presented that pertain to pure visual compositional structure for 3-D asymmetry. An organization can be seen as a “master plan” that maps out the routes and interactions between all visual aspects of the composition (i.e. elements, movements & forces and relationships). An organization can also be seen as the “accumulated structure” that each element can give to the total expression of the work. In other words, there is a direct correlation between the visual integrity of the individual elements and the overall organization.

The message that is meant to be communicated through the overall “gestalt” has strong bearing on the organization and character of the work. However, the scope of this handbook is to focus on the concrete descriptive visual information that can be observed more or less independent of the interpretation of the work. It may seem counterproductive to isolate form from content, since the goal in any visual work is to synthesize these two worlds. Yet, developing the ability to abstract the 3-D visual structure that is inherent in anything that exists in our 3-D world, adds objective viewpoints to the creative process of “shaping” new ideas.
To determine the orientation of an object within a 3-D matrix requires an active participation from the observer. Visual information must be gathered from different viewpoints, at different distances. 3-D spatial perception demands a stereoscopic vision, i.e., to observe with both eyes, as well as a high level of concentration because the different views must be fused together to give an integrated spatial interpretation. In comparison, the orientation of an element on a 2-D picture plane can be determined with one eye closed and from one fixed view.

**Depth perception**

All three dimensions, vertical, horizontal, and depth, are implicit in the 3-D matrix, however, the third dimension, depth, is the key to experiencing space. The depth dimension embodies a 3-dimensional quality in itself, unlike the 2-D more graphic representation of vertical and horizontal. A vertical dimension can be defined without relating it to the other dimensions; it is parallel to the plumb line that is governed by the laws of gravity. The horizontal dimension does not need to be defined in relation to the vertical or depth dimensions; it is parallel to the horizon. We are extremely sensitive to any deviation from the vertical and horizontal dimensions, which at times can be a source of irritation (like a picture hanging askew).
ORGANIZATIONAL FRAMEWORKS

The three organizational frameworks are:

static - the elements are aligned with the 3-D spacial matrix.
dynamic - the elements are angled to the 3-D spacial matrix.
organic - the elements are curved within the 3-D spacial matrix.

The above frameworks outline three distinct ways to organize elements in space (Fig. 83a-c). The static framework organizes the elements parallel to the 3-dimensions and is therefore the most rigid framework. In the dynamic and organic frameworks there are an infinite number of degrees of angles and curvatures that deviate from the vertical, horizontal and depth dimension. The position of each element is defined in reference to the 3-dimensions. The organizational framework should correlate to the shape and character of the elements as well as their interrelationships applied within the framework. This correlation implies a logical hierarchy from the smallest detail to the overall composition.

**STATIC** - Three straight lines parallel with the vertical, horizontal and depth dimensions, respectively.

**DYNAMIC** - Three uneven triangles are placed at an angle to the vertical, horizontal and depth dimension, respectively. The diagonal properties of these triangular planes are reinforced and strengthened within a dynamic framework.

**ORGANIC** - Three curved lines curve to the vertical, horizontal and depth dimensions, respectively. An element with an inner axial curvature is a prerequisite for the organic framework.
The concepts of symmetry and asymmetry apply either to the organization of elements in a composition and/or to the internal structure of a single form.

**SYMMETRY**
Strives to maintain regularity and creates an equilibrium through repetition and the cancellation of movements and forces by identical opposing elements and forces. A sphere is the only perfectly symmetrical form since it is identical from all views.

An egg has bilateral symmetry, i.e. identical qualities on both sides of a vertical dividing line, however, the composition is asymmetrical from top to bottom.

**ASYMMETRY**
Strives to maintain diversity and aims to counterbalance elements, movements and forces so as to compensate for opposing strengths and weaknesses, yet does not lead to repetition.

Symmetry and asymmetry can also be seen as two extreme poles within a spectrum. A composition can involve a combination of symmetrical and asymmetrical qualities. Figure 85a–c shows three different compositions that exemplify the symmetry/asymmetry spectrum.

The visual method presented throughout this book emphasizes asymmetry in order to create visual challenges from each view with respect to the 3-D visual statement.
The concepts of symmetry and asymmetry apply either to the organization of elements in a composition and/or to the internal structure of a single form.

**Symmetry**

Strives to maintain regularity and creates an equilibrium through repetition and the cancellation of movements and forces by identical opposing elements and forces. A sphere is the only perfectly symmetrical form since it is identical from all views. An egg has bilateral symmetry, i.e. identical qualities on both sides of a vertical dividing line, however, the composition is asymmetrical from top to bottom.

**Asymmetry**

Strives to maintain diversity and aims to counterbalance elements, movements and forces so as to compensate for opposing strengths and weaknesses, yet does not lead to repetition. Symmetry and asymmetry can also be seen as two extreme poles within a spectrum. A composition can involve a combination of symmetrical and asymmetrical qualities. Figure 85a-c shows three different compositions that exemplify the symmetry/asymmetry spectrum.

The visual method presented throughout this book emphasizes asymmetry in order to create visual challenges from each view with respect to the 3-D visual statement.

Surface qualities and visual contrasts, such as sharp edges or silhouettes, usually dominate visual perception. If these more superficial stimuli are strongly integrated with the activity of movement and forces within and beyond the elements then a clear 3-dimensional visual balance can be developed (Fig. 86).

**Balance**

Balance involves the interaction between the properties of the elements and their movements/forces so as to establish an equilibrium or counterbalance throughout the composition. Balance can be thought of in terms of:

**Structural balance** - deals with the physical ability of a composition to "stand on its own". The distribution of weight and the combined structural features such as joints, supportive elements, strength of transitional areas between forms etc. determine the structural balance of the composition.

**Visual balance** - deals with perceptual dynamics of the composition, taking into account the visual potential of both positive and negative elements. The first step is to visualize an equilibrium or counterbalance between the axial movements and the visual forces within and beyond the elements. To develop such an "all-around mental image" of how the movements and forces interact within a 3-D spatial context is a very abstract experience. It is, however, the "scaffolding" on which elemental properties and relationships are built and therefore is essential for perceiving or developing visual balance. The next step it to see how the proportions of the elements are distributed within the composition and how they are correlated to the specific configuration the composition takes on from different views.

The tional relationship between accents (a) and (b) in figure 86 counterbalance directional forces. Figure 87 illustrates the tional relationships in figure 86.

Symmetry/asymmetry and frameworks

The perception of visual balance must take into account whether the composition is based on symmetry or asymmetry (see p. 52). The organizational framework, i.e. static, dynamic or organic, also set the conditions for visual balance. Figure 88 shows three curved geometric volumes in an asymmetrical, dynamic framework.

The concept of balance is constantly challenged within the visual field. The tolerance for accepting asymmetrical balance varies from person to person, since the perception of balance has to do with relating the proportions and activities within a composition to how we sense equilibrium within our body and our previous visual experiences.
Orientation specifies the location of each element in relation to the spatial matrix. Figure 89 illustrates the terms used in orienting the elements, i.e., direction, position and tip/rotation.

- **Direction**: the general movement of the primary axis in reference to the 3-dimensions of space, e.g., angled to the vertical.

- **Position**: to shift the position of the element up or down along the defined directional movement.

- **Tip/Rotation**: to turn the element around its primary axis.

Figure 90 shows how the above terms of orientation are applied. The direction of the plane moves parallel to the depth dimension and is rotated 90 degrees.
ORIENTATION of PLANES in a STATIC FRAMEWORK

The first structural features to be considered within the organizational framework is the orientation of the primary axis of each element. In figure 92 the three rectangular planes are organized so that the primary axis of one plane moves vertically (a), another plane moves horizontally (b) and the third plane moves in depth (c).

In figure 93 a 90 degree rotation of each plane around its primary axis has been performed (a – a’, b – b’, c – c’). This rotation is meant to illustrate the six different possible orientations of planes within a static framework. Since there are only three different dimensions, the primary axis of two planes must share the same dimension, i.e. the primary axis of (a) and (a’) share the vertical dimension, (b) and (b’) share the horizontal dimension and (c) and (c’) share the dimension of depth.

The principle difference in each of these pair of planes is that the secondary axis of the two planes move in an opposing dimension (Fig. 91).
This model in figure 94a-b applies some of the terms presented in all four chapters. The following features are incorporated in this model:

* A static organizational framework governs the position of the positive and negative elements.
* The entire composition is asymmetrical.
* The spacial enclosures (x), (y) and (z) are open negative volumes.
* Due to the compatibility between the rectangular shape of the planes and the static organizational framework, the shape of the spacial enclosures are also rectangular and of contrasting proportions.
* The inherent proportions of the planes and the spacial enclosures are all different from each other.
* There is a hierarchy of order of the planes, which is dependant on an inner relationship of comparative size and proportion, position and role in creating spacial qualities. Plane A appears to have a dominant role, plane D a subdominant and plane B a subordinate role in relation to A and D.

The purpose of this exercise is to define at least 3 different spacial enclosures within an asymmetrical static organization of planes. The positive and negative elements (see chapter I, p. 7) all have varied proportions and spacial orientation. Each element moves as 3-dimensionally as possible within the spacial matrix.

The spacial enclosures marked (x), (y) and (z) in figure 94a-b are open from at least three sides and are therefore all open negative volumes.

All 6 planes in the model can be seen in both figure 94a and b, however, in figure 94b the vertical plane D overlaps plane C and F which visually interrupts the surfaces C and F which changes the visual proportions.
Figure 95 maps out the direction, position and rotation of each of the six planes (A-F). The dotted lines on the planes mark the primary axis = 1 and secondary axis = 2 as well as the dimensional direction of the two axes; vertical = v, horizontal = h, depth = d. As an example, plane A shows that the primary axis moves vertically (v1) and the secondary axis moves horizontally (h2).
The overall proportion has to do with the entire shape of the composition and summarizes the proportions of the positive and negative elements. A way to perceive the overall proportion is to observe the composition "out of focus" (e.g. by squinting). This allows the details and the sharp silhouette to fade as you see the object from all sides so that the entire composition is generalized into pure movements and proportions.

Figure 96 shows three curved geometric forms joined together in a dynamic framework. The gray-shaded surface in figure 98 is meant to illustrate the overall proportions of the model in fig 96. The illustration can not represent the 3-D volumetric qualities of the overall proportion, but it does show that the main directional movement is angled to the vertical dimension and that the composition is asymmetrical.

A comparison of the principally different ways of seeing form and space is shown in figure 97 and 98. Figure 97 zooms in on details within the model while figure 98 "shadows" these superficial qualities.

The "U"-joint in figure 97 illustrates how the lines around the joint are shaped in comparison to the overall proportions in figure 97 (a more complete joint analysis can be found on page 29).
Professor Rowena Reed was a sculptor and teacher, who was born at the turn of this century. She belonged to the generation of artists that took on the challenges of introducing the principles of the modern movement into art and design education in America. Through her close working relationship with her husband, painter Alexander Kostellow, she collaborated in the development of a logically structured foundation for the visual arts. Together Reed and Kostellow worked out a visual foundation program that introduced the different levels of visual complexity through concrete experiences in 2-D and 3-D mediums. The terminology was consistent throughout the program and reinforced at each level. The exercises were intended for artists as well as designers, since the ideas explored in the foundation courses were “meant to apply to all forms of visual expression” (2).

Alexander Kostellow outlined the first stages of this visual program through his teaching positions in the painting departments at Kansas City Art Institute in Missouri and at Carnegie Institute in Pittsburgh, Pennsylvania. He began to formulate “definitions for the elements of visual experience and to identify the principles underlying the organization of these elements into significant form.” (2). The program was established at Pratt Institute in NYC 1936 as the “foundation program” for all first year students in the Art and Design Departments. Rowena Reed had responsibility for developing and teaching the 3-D courses. When Reed was invited to Pratt, together with Alexander Kostellow, she joined the teaching staff that established one of the first Industrial Design (ID) Departments in the USA. She brought her background and working methods as a sculptor into the education of an industrial designer and used her more intuitive visual approach and 3D-teaching methods with the structured visual foundation. The Industrial Design Department, under the leadership of Kostellow, integrated the foundation program into its own curriculum. Rowena Reed was therefore able to develop and teach advanced studies of form and space at the ID department, as well as lead and/or collaborate in practical/functional design projects that applied the visual foundation.

After the early death of Alexander Kostellow in 1954, Rowena Reed continued to teach for more than thirty years and developed new directions within the visual program. Her devotion to explore the fundamental issues of 3-dimensional visual phenomena assured that her comments and criticism were unaffected of trends and “isms” that superficially shape the art and design world.
Reed’s teaching methods

Rowena Reed’s 3-dimensional sensitivities were intimately linked with her ability to abstractly analyze and discern visual complexity. Reed’s method of teaching encouraged a creative process that gave her students freedom of expression and ensured 3-D visual thinking. Through a spontaneous confrontation with 3-D sketching, a variety of visual expressions would begin to take form. The power, identity and idiosyncrasies of each sketch could potentially contribute to the final “visual statement”, either directly or indirectly. The development of a gestalt / image progressed through different phases that interwove this spontaneous method with an analytical approach which involved determining the inner structure and abstract organization of a composition.

The source of inspiration for Rowena Reed’s dynamic sketching process presumably stems from her experiences with German - American painter Hans Hofman. Hofman’s painting and teaching methods “initiated the transformation of abstract art from the invention of images, drawn before they were coloured, to their creation in the process, or action, of painting” (3). Rowena Reed brought that abstract spontaneity from painting into developmental methods of sculptural work without reducing 3-dimensional complexity. She was very clear about distinguishing between the 2-D vision and tools of a painter and those of sculptor. Students were usually discouraged from working out ideas in a 2-D media in her courses, because line, surface quality, shading, color and fixed view-points were stressed when working 2-dimensionally. In contrast, working solely in a 3-D media, emphasis is placed on volume, space, depth and all-roundness, which is vital in communicating sculptural experiences.

Toward the last part of her teaching career, Reed became involved in architectural problems and art installations where spatial articulation was imperative. She worked out ways to explore static, dynamic and organic space where expansion of the “total negative volume” was a central concept. These space studies were a further development of her understanding of convexity and concavity which the Russian - American sculptor Alexander Archipenko initially introduced to Reed.

Archipenko was Reed’s most important link to the modern development within the sculptural arts. The controversial ideas of shaping space as a “tangible” element as well as the constructivistic attitude that Archipenko fostered through his teaching helped to build the platform on which Rowena Reed founded her teaching. The following citation of Alexander Archipenko (1) gives insight into his view of convexities/concavities and the creative process:

“It is evident that in sculpture each point of the surface would have meaning and be related to millions of other points of the surface. Likewise, relief and concave are reciprocally integrated. It is exactly as in music; each note has its psychological significance while it is related to every other note and pause in the composition”.

Alexander Archipenko was considered one of the first truly modern sculptors of the 20th century (5). His classic training gave him the technical working methods of a traditional sculptor and his inner artistic vision freed him from the conservative bonds with materials and representational imagery. Archipenko left Russia around the onset of the revolution and was therefore not engulfed in the Russian constructivist movement. His unique 3-dimensional organic methodology was based on abstraction of the figure and did not share the dogmatic geometric grounds nor the social/political connections to art.
Previous documentation

Neither Rowena Reed nor Alexander Kostellow documented their educational program or the theoretical framework that structured their visual vocabulary and principles. Many of the concepts Alexander Kostellow integrated into the comprehensive visual structure came from contemporary artists that were active in New York City in the beginning of this century, many of which had emigrated to the US from Europe.

There is little documentation by others concerning Reed’s or Kostellow’s methods of teaching and educational material within the visual field. Arthur Pulos writes about Alexander Kostellow’s role in establishing educational requirements for industrial design programs as well as heading committees that worked to strengthen the profile for the industrial design profession. These issues demanded all Kostellow’s time outside of the Department.

Research is needed to trace the individual artists that Alexander Kostellow studied and worked with, who influenced and supported him during the initial phase in creating an objective base for the visual arts and design as well as Kostellow’s and Reed’s step by step development of their principles of visual relationships.

The structure I have attempted to document in this book is therefore my interpretation and further development of Rowena Reed’s 3-D foundation.

References regarding Background Rowena Reed

HISTORICAL CHART

The chart on the this page is derived from the chart "Art streams of the 20s" in John Willett’s book “The new sobriety - art and politics in the Weimar Period 1917-33”. This chart has been adapted to put Reed and Kostellow in a historical context and points to some schools / movements that share a common source of inspiration.

The dark grey blocks mark the initial events of Reed’s and Kostellow’s development. The light grey blocks outline the movements and schools that contributed to establishing the bases of artistic expression that stem from the visual arts themselves and the creative process.

Alexander Kostellow 1896 - 1954
Rowena Reed-Kostellow 1900 - 1988
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First I wish to acknowledge Rowena Reed, my teacher and friend, for her never-ending enthusiasm in sharing her experiences and knowledge. I am forever indebted to her for the generosity and concern she showed me as I struggled to understand the significance of the visual concepts and principles she taught.

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Through Konstfack’s Artistic Funding program (Konstnärlig Utveckling = KU) I continued to explore different methods of computer documentation in collaboration with Sven Ringmar using Macintosh and ION digital camera and Mikael E. Widman from the Royal Institute of Technology, using Integraph CAD. The CAD illustrations in chapter III and IV were created by Mikael Widman. Songping Lee who heads our Computer Department has also been very helpful.

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Funding by the National Department of Education (UHÄ) made it possible for me to compile my teaching material into this book. I would again like to thank Lars Lallerstedt for initiating and following this project.

Finally, to my husband Gunnar - Thank you for your constant love and encouragement as I developed my art and teaching in Sweden and for acting as my editor as we worked to put the pieces for this book together.
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For references regarding the background of professor Rowena Reed, see also p. 61.
Development of the curriculum at the Department of Industrial Design (ID) at the University College of Arts, Crafts and Design in Stockholm has been carried out during a three year project. The purpose has been to produce teaching materials for our own educational program within the Department, but also for exchange with other design schools in Sweden where similar curriculum developmental projects are under way.

The focus has been on the following areas:

**Designmetodik** (Design Methodology), Vilda idéer och djuplodande analys; om designmetodikens grunder, belyser hur designarbetet planeras och genomförs i sina olika faser där funktionsanalys utgör en central del av arbetsgången hos en designer.

**Three-Dimensional Visual Analysis** (Form- och Rumsstudier), shows how form may be created, influenced and perceived in a structured manner. These visual studies constitute a link between fine and applied arts by developing a "form grammar" which supports both application and education.

**Modellbyggnadsteknik** (Model Making), introducerar material och tekniker för modellframställning i olika ambitionsnivåer. Skilda materials förutsättningar och begränsningar samt bearbetningsmetoder presenteras med råd och anvisningar om hur ett gott resultat ska uppnås och misstag undvikas.

Industrial Design is a young education with a great need for curriculum development. The future intention with this series of books is that other subjects will be added as the basic teaching program progresses.

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