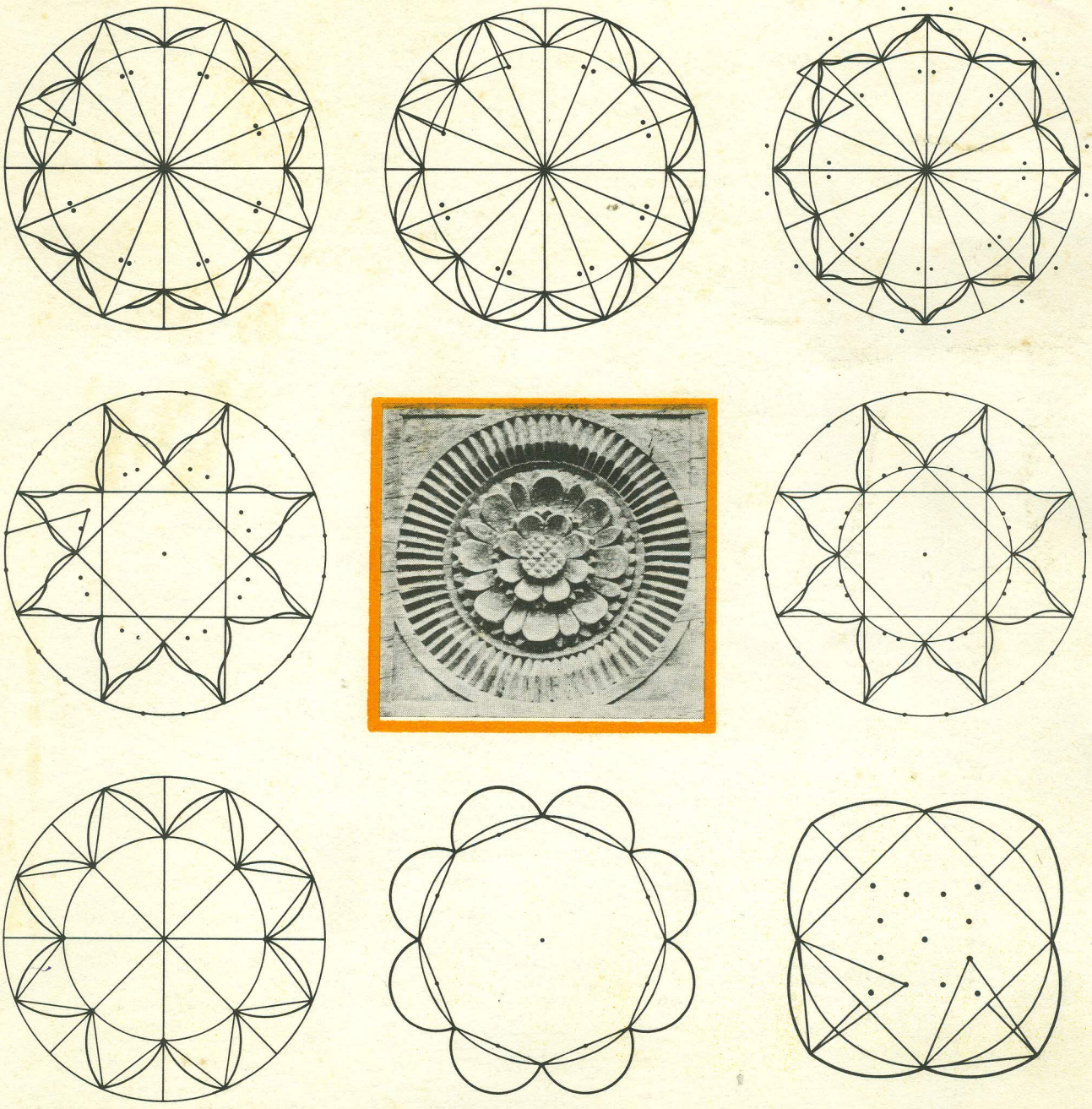
July - December 1986

# अभिकल्प





# Abhikalpa

**The Journal of Industrial Design Centre**

**Issue 3** **July - December 1986**

Contents



**Cover:** Diagrams for construction of various lotus flower shaped 'Yajna-kundas' — ritual fire-pits. (Drawings based on instructions given in 'Mandapa Kunda Siddhi').



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Phototypesetting: M.S. Rajan
Printed in the IDC Press by G.R. Chilap.

'Abhikalpa'
the six monthly journal of Industrial Design Centre, Indian Institute of Technology, Bombay is published for private distribution only to designers, design educators and others connected with the design profession.

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## Understanding Basic Design

Ever since the 'Vorlehre' (foundation programme) of the Bauhaus - a preparatory course in 'basic design' has been a standard part of the curriculum of most art and design schools in the world. The objectives of these basic design courses are generally stated as providing the student with a 'grammar' of form - giving a 'vocabulary' or 'alphabet' of form which could be used to create 'words' and 'texts' in later 'real' assignments. The assignments typically revolve around pure formal exploration and skill training.

Surely the objectives of a course in BASIC design have to go beyond syntax training. All too often, the present courses in basic design end up actually freezing the attitudes of the students towards form - making their formal vocabulary so selective as to exclude many kinds of expressions.

Should not a course in 'Basic Design' lead to an understanding of the basic design in everything around us? Should it not attempt to provide a direct and personal experience of that unifying order which is the basis of all existence and all phenomena? Should not basic design extend its scope from consideration of the 'Pleasant' (external physical form) to 'Good' (inner form)? Because only through the awareness of this subtle order - the all pervading essential design will be seen - filling the student with an ever anew sense of beauty and majesty of it all.

J. Krishnamurti - one of the greatest philosophers and seers of our times - concerned himself with basic education of this kind: trying to liberate the intellect itself from the constricting influence of thought. Krishnamurti's approach to education and organisation of education needs to be applied to design education as well, if we are really concerned with bringing about a fundamental change and freeing ourselves of all dogmas.

Photo: P.M. Dalwadi



# Truth is a pathless Land

## J. Krishnamurti

I maintain that Truth is a pathless land, and you cannot approach it by any path whatsoever, by any religion, by any sect. That is my point of view, and I adhere to that absolutely and unconditionally. Truth, being limitless, unconditioned, unapproachable by any path whatsoever, cannot be organised; nor should any organisation be formed to lead or coerce people along any particular path. If you first understand that, then you will see how impossible it is to organise a belief. A belief is purely an individual matter, and you cannot and must not organise it. If you do, it becomes dead, crystallised; it becomes a creed, a sect, a religion, to be imposed on others.

This is what everyone throughout the world is attempting to do. Truth is narrowed down and made a plaything for those who are weak, for those who are only momentarily discontented. Truth cannot be brought down, rather the individual must make the effort to ascend to it. You cannot bring the mountain-top to the valley .....

So that is the first reason, from my point of view, why the Order of the Star should be dissolved. In spite of this, you will probably form other Orders, you will continue to belong to other organisations searching for Truth. I do not want to belong to any organisation of a spiritual kind; please understand this....

If an organisation be created for this purpose, it becomes a crutch, a weakness, a bondage, and must cripple the individual, and prevent him from growing, from establishing his uniqueness, which lies in the discovery for himself of that absolute, unconditioned Truth. So that is another reason why I have decided, as I happen to be the Head of the Order, to dissolve it.

This is no magnificent deed, because I do not want followers, and I mean this. The moment you follow someone you cease to follow Truth. I am not concerned whether you pay attention to what I say or not. I want to do a certain thing in the world and I am going to do it with unwavering concentration. I am concerning myself with only one essential thing: to set man free. I desire to free him from all cages, from all fears, and not to found religions, new sects, nor to establish new theories and new philosophies. Then you will naturally ask me why I go the world over, continually speaking. I will tell you for what reason I do this; not because I desire a following, not because I desire a special group of special disciples. (How men love to be different from their fellow-men, however ridiculous, absurd and trivial their distinctions may be! I do not want to encourage that absurdity.) I have no disciples, no apostles, either on earth or in the realm of spirituality.

Because I am free, unconditioned, whole, not the part, not the relative, but the whole Truth that is eternal, I desire those, who seek to understand me, to be free, nor to follow me, not to make out of me a cage which will become a religion, a sect. Rather should they be free from all fears—from the fear of religion, from the fear of salvation, from the fear of spirituality, from the fear of love, from the fear of death, from the fear of life itself. As an artist paints a picture because he takes delight in that painting, because it is his self-expression, his glory, his well-being, so I do this and not because I want any thing from anyone. You are accustomed to authority, or to the atmosphere of authority which you think will lead you to spirituality. You think and hope that another can, by his extraordinary powers—a miracle—transport you to this realm of eternal freedom which is Happiness. Your whole outlook on life is based on that authority.

You are all depending for your spirituality on someone else, for your happiness on someone else, for your enlightenment on someone else.... when I say look within yourselves for the enlightenment, for the glory, for the purification, and for the incorruptibility of the self, not one of you is willing to do it.

No man from outside can make you free; nor can organised worship, nor the immolation of yourselves for a cause, make you free; nor can forming yourselves into an organisation, nor throwing yourselves into work, make you free. You use a typewriter to write letters, but you do not put it on an altar and worship it. But that is what you are doing when organisations become your chief concern. 'How many members are there in it?' That is the first question I am asked by all newspaper reporters. 'How many followers have you? By their number we shall judge whether what you say is true or false.' I do not know how many there are. I am not concerned with that. If there were even one man who had been set free, that were enough....

Again, you have the idea that only certain people hold the key to the Kingdom of Happiness. No one holds it. No one has the authority to hold that key. That key is your own self, and in the development and the purification and in the incorruptibility of the self alone is the Kingdom of Eternity....

You have been accustomed to being told how far you have advanced, what is your spiritual status. How childish! Who but yourself can tell you if you are incorruptible?...

But those who really desire to understand, who are looking to find that which is eternal, without a beginning and without an end, will walk together with greater intensity, will be a danger to evertything that is unessential, to unrealities, to shadows. And they will concentrate, they will become the flame, because they understand. Such a body we must create, and that is my purpose. Because of that true friendship there will be real co-operation on the part of each one. And this not because of authority, not because of salvation, but because you really understand, and hence are capable of living in the eternal. This is a greater thing than all pleasure, than all sacrifice.

I have now decided to disband the Order, as I happen to be its Head. You can form other organisations and expect someone else. With that I am not concerned, nor with creating new cages, new decorations for those cages. My only concern is to set men absolutely, unconditionally free.

(From the speech dissolving the Order of the Star at Ommen Camp, Holland on August 2, 1929).

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# KOHSEI

## Basic Art & Design as a New Professional Genre

**PROF. NAOMI ASAKURA**
University of Tsukuba, Japan

In contemporary art and design, one of the most important problems is the in-depth study of its fundamentals, along with the unification of various genres within the field. "Kohsei" is the specialized study of these problems.

To explain the principles and aims of Kohsei, it will be best to compare it with the basic sciences in the field of natural science.

In the developing sciences, the special subject of study becomes fractionalized into many independent genres. So, unification is now needed for the contemporary sciences. Recently, we have come to have new specialities included in the unification of sciences such as basic medicine and engineering sciences. Such specialities are for studying common, basic and important problems in each field. In medicine, for example, internal medicine, surgery, otolaryngology, etc. belong to clinical medicine. Basic medicine is the science which studies common, basic and important problems in each genre of clinical medicine. In the field of basic medicine, there is anatomy, pharmacology, biochemistry, pathology and so forth. Medical science will develop truly by studies of both basic and clinical medicine.

Well, what is equivalent to basic sciences (basic medicine, engineering sciences, etc.)? I want to name it "basic art and design". Basic art and design should be the genre dealing with common, basic and important problems in art (painting, sculpture, etc.) and design (visual communication design, industrial design, interior design, etc.). The subject includes color, shape, texture; and still more, composition, structure and mechanism, illusional visual effects, methods of bringing up aesthetic sensation and creativity, etc. That is to say, basic art and design is Kohsei itself, which is being taught widely in my country and is my speciality.

The National University of Tsukuba offers "Kohsei Courses" in the Professional School of Art and Design to students who aspire to specialize in the basic fundamentals of fine arts and design.

The purpose of studying Kohsei is to create new beauty, by refining methods in creating forms according to their essences and rules, and by trying out all formative possibilities in materials from every aspect. To our way of thinking, this is the most important mission in the education of progressive artists and designers at present and in future. We therefore offer Kohsei training in every grade of both undergraduate and graduate schools.

In the past, Bauhaus has already pointed out the importance of a basic training in the "Vorlehre" (primatry education) programme. We have found a great value in the contributions by Moholy-Nagy and Josef Albers as educators in the field. We feel a professional obligation to these predecessors to further develop their thinking and work. Would it be possible to realize this at present when social conditions are different from the Bauhaus time? We would feel most fortunate if our Kohsei courses gave an answer to this question.

In order to clarify this point, let me explain it in different words. For the clear understanding of our Kohsei, one needs to know the similarities and differences between Bauhaus "Vorlehre" and our "Kohsei". That is to say, it would be

especially important to point out their differences. The "Vorlehre" of Bauhaus in the first six months is meaningful only as a "basis" for arts and design. If we use an analogy that each specialization in Arts is a "tree", his "Vorlehre" is earth, the "base", where the tree grows its root. Thus, a tree takes good nourishment from mother earth, and each tree - Graphic Design tree, Product Design tree, Photography tree etc. - grows up. In these cases, the base is common ground for every tree and spreads in width. Compared to this, Kohsei in our conception is not only the base but also a tree as well. It is one of the specializations, a "genre" in the world of arts. It is equal to the status of mathematics which is basic to various sciences and engineering, but it is also an independent tree which has its specialized field in the academic world. Since Kohsei is a tree with its own value, we set up courses for its development in all the years of undergraduate, as well as graduate school where highly pure studies in forms and colours are carried out, while Bauhaus "Vorlehre" remains only as a base, showing horizontal width and vertical growth. This is the basic differences between the two ideas.

Pure studies on forms and colours and their combinations are important for basic visual creating. Through these courses, we teachers, endeavour to teach our students art and design with the purpose of nurturing sharp aesthetic sensitivities in colour, form, composition, construction, formal probabilities of materials and Gestalt-psychology, as well as a strong contemplative faculty which enables creative work to survive under the various conditions in this changing world.

The characteristics of Kohsei are as follows:

1) It is a genre worth studying as one of the important specialities in art and design just like painting, sculpture, craft, photography, graphic design, product design, etc.

2) It deals with the subjects about common, basic and important problems in art and design.

3) The primary field of Kohsei is useful in basic education in the professional school of art and design.

4) The aim of the basic field of Kohsei corresponds to the aim of raising the basic ability of art and design of the pupils. So, the principles of Kohsei are useful in primary education, too.

**The Contents of Kohsei**

What is it that is basic and important and included in all genres of Art & Design? It is the colour, the shape and the texture. These elements can be said to be the words without which no design can be made. And as the sentence needs grammar and syntax besides the words, in the world of art and design, it is necessary to have grammar which lays down the rules for construction of design statements. Like syntax, these studies are common to the whole of art and design activities.

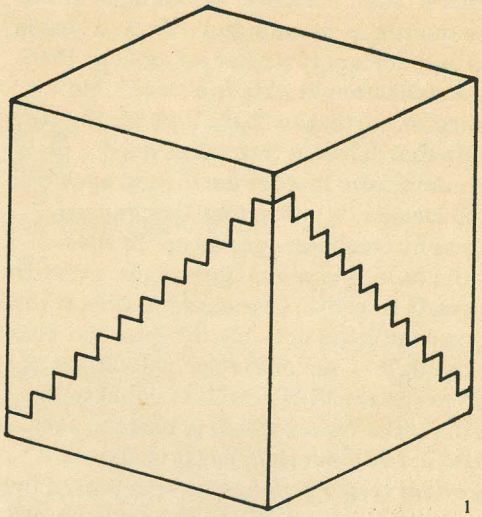
Similarly, in the field of Art, Kohsei is not the pursuit for specific meaningful form which is concrete and tangible like a nude or the statue of Venus. The great role of Kohsei in three-dimensional space is to create the general intangible forms (abstract forms) - as opposed to the concrete forms mentioned above - as systematically as possible; because these general intangible forms will include in them possibilities of all tangible forms.

Because study of Kohsei covers such a wide area, we first divided these into Colour and Form studies for the sake of convenience. The form studies are further classified as plane kohsei, cubic kohsei and space kohsei. Kohsei concerns itself with the universal and the general in formal studies; and not with the design of the form and appearance for some special purpose, as for example, designing the appearance of a car.

**The use of Kohsei**

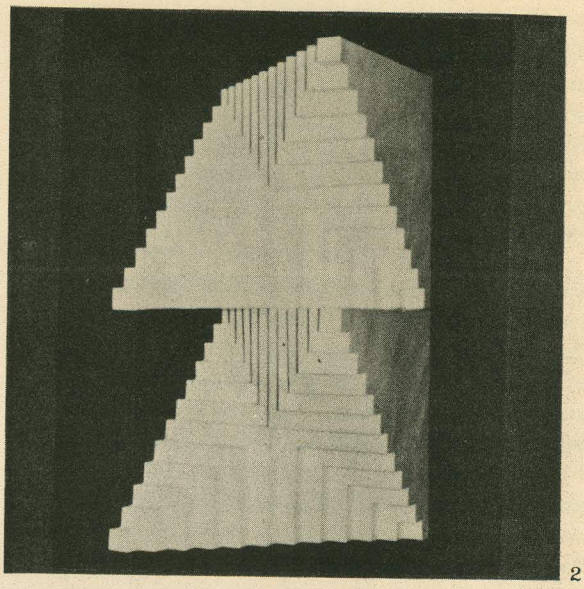
The study of Kohsei is useful in several ways. First, a deep pursuit of Kohsei as a special field of science, can lead to a much higher development of the grammar and syntax of Art and Design. Therefore, through systematic Kohsei studies, it will be possible to advance a system of forms, or an essay on shape or a methodology of conception or a theory of vision. All art and design will be enriched as these theories are refined and become more reliable. The development of art and design will continue a sound and great growth by combining the improvements of each field in its vertical classification and the study of composition which is the major genre of horizontal classification. And when we move the basic Kohsei to the educational place, to experience all kinds of materials supporting all activities of art and design; to research those possibilities

which have somehow been deprived from it; to pursue the compositional elements like point, line, plane, cube, space etc.; to become familiar with the organic methodology about combination of colours; and to get accustomed to just the methodology by exercising all above things - it is clear that Kohsei would have a usefulness beyond the mere content of these activities. It has the possibility to hone the aesthetic sensibilities about form, colour, composition; and to enrich the power of Design or conception, i.e., creativity. For this reason, in Art and Design schools in Japan, Kohsei is usually an important part of curriculum as a basic course that the freshmen must master.



1

As mentioned above, it is important to understand that Kohsei has two kinds of use and character. One is that Kohsei is a special field growing high like the special branches of other science or other art genres (development in a vertical direction). And the other is Kohsei as a basic course of liberal arts given to the lower grades as a fundamental subject in their majors (expansion in a horizontal direction).

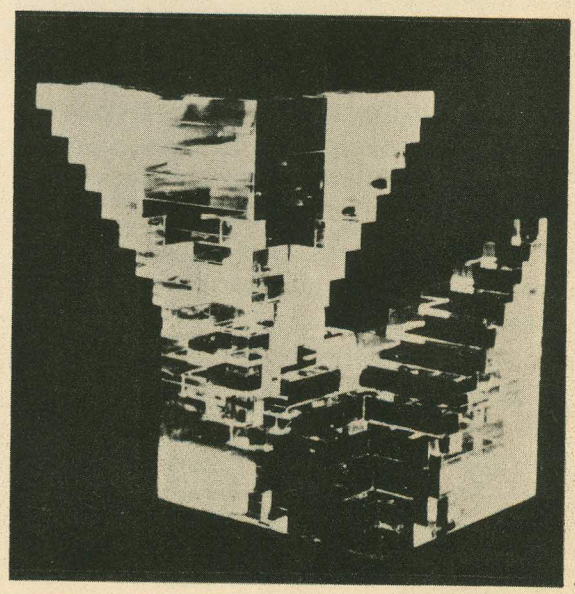


2

**Kohsei in three-dimensional space and its adaptation**

I have been asked often to describe ways and instances of how Kohsei could be used for practical work. I would like to illustrate this point, with examples of my work produced by applying Kohsei in the three-dimensional space. In the world of three dimensional space, the composition of form can be divided largely into centripetal composition (garment, sculpture etc.) which consists of reducing the size more and more; and centrifugal composition (attaching, combining, accumulating) which consists of enlarging the size by adding different forms again and again. One of the most fundamental method for division in centripetal composition is the equal partition. A regular polyhedron and a sphere are the most basic forms in three dimensional shapes. I studied assembling combinations of the above two things: cube which is the basic form and two equal division; and made a series of works of composition

(picture 1-2)



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The method of two equal division is not a unique one in the world of three-dimensional shapes. There are at least two kinds: division in two equal volume and forms; and division in equal volumes but different shapes (picture 3)

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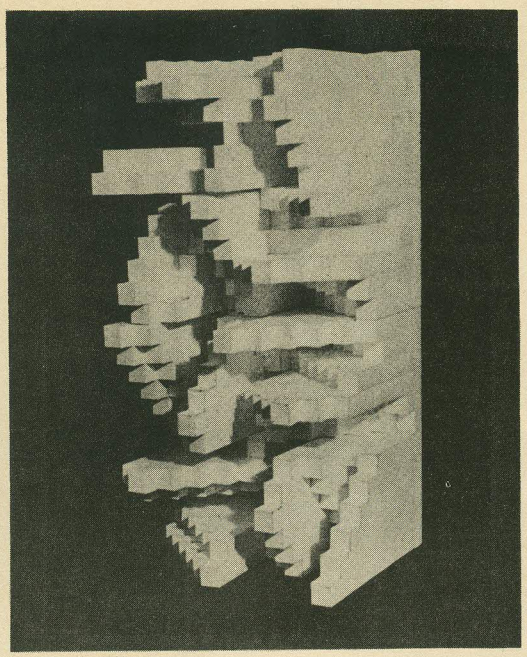

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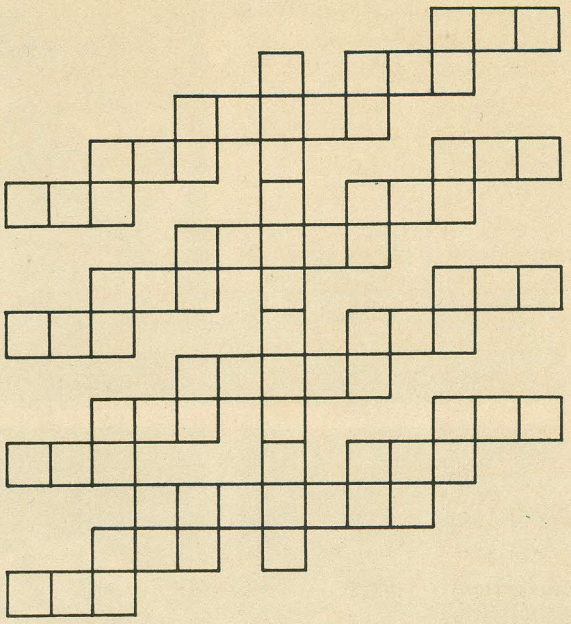

Taking an example of the centrifugal composition which is obtained by attaching the cube, the assembled cube (picture 4) is constructed by one sheet of development figure like picture 5.

Besides the cube there are four kinds of regular polyhedra: a regular tetrahedron, a regular octahedron, a regular dodecahedron, and a regular icosahedron. Among these the most simple one is the regular tetrahedron which is made by joining four regular triangles. Picture 6 is the assembled solid that results when regular octahedra are attached to the surrounding space of that shape and this new solid has again the appearance of a regular tetrahedron.

The shape in picture 7 is created by projections and depressions on the surface of dodecahedron which is the only solid which has the regular pentagon as a unit plane among the regular polyhedron. Several cover designs for magazines have been developed by projecting striped coloured lights from different directions on these shapes (8-9). These designs result from the synthesis of composition of coloured light and solid composition. Considering the rapid development of light as an art and design media now-a-days, it was recognised that basic study of light is very important and it was introduced in student exercises in Kohsei in our University. Some of these studies explore holographic images made by arranged interference operation of light (laser), resulting in sculpture by light.

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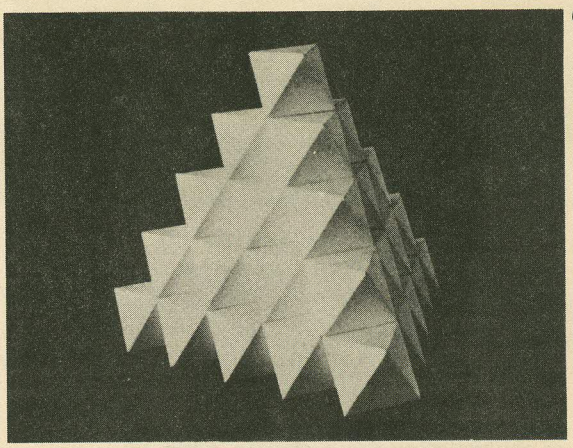

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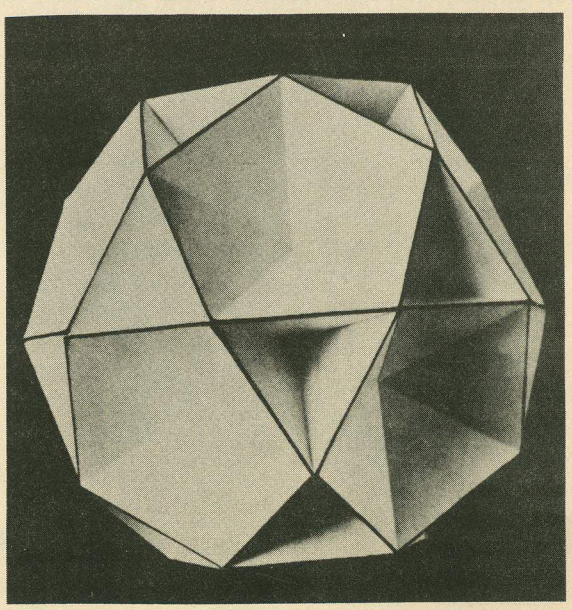
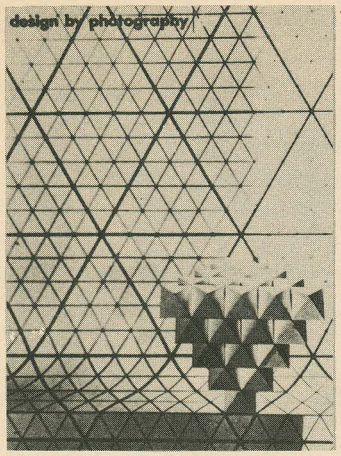


8 design by photography



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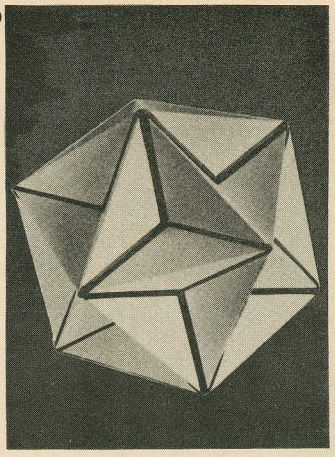

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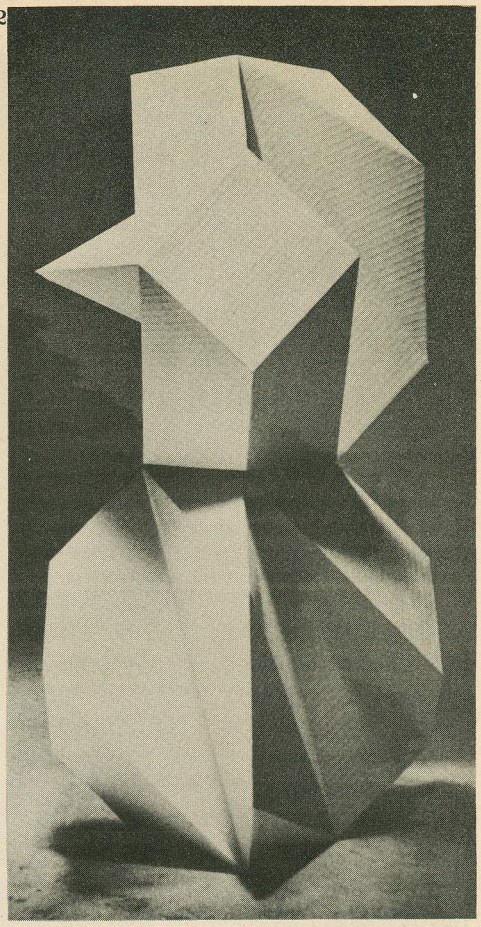
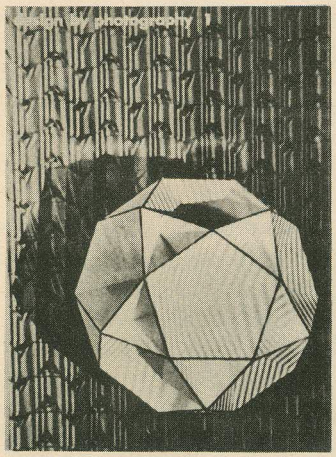


9 design by photography



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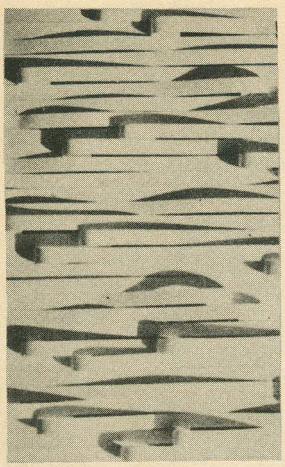
The basic solid shapes used for the above sculptures or designs form a system of equal-edge-polyhedral shapes. (Fig 10-12). To make the system of the regular polyhedra, and to teach these forms systematically means not only to know the various relationships of shapes used for the above, but also to show the method of constructing these shapes. From an understanding of these fundamental relationships, it is very easy to create new shapes.

Next, it is necessary to examine the constructing possibility of materials in order to study the relation between forms and materials in three-dimensional composition. Several exercises have been developed to do this, and pictures 13-16 show some examples and their applications obtained from a study of character of paper from the point of view of solid construction. Picture 13 is the relief composition produced by rolling paper for making the smooth curved surface from one sheet of kent paper. The slim edges express and make one feel the light character of paper. Picture 15 has the value of not cutting or folding in making that pattern, and even this has been made from one sheet of kent paper. This shape is so appropriate to make with paper that it is very difficult to do it with a different material.

A plane material like paper can be folded and become strong; or one may make cuts in it which make it weak. If you design a form using these two characteristics, something like the work in picture 17 may result. This form is bound and assembled strongly, but without using any adhesive so that it can be opened and untied freely. And because it is a kind of unit composition which is constructed with the same units, it is appropriate for mass production. Of course, it has not been made with some special practical purpose in mind, but is a structural shape which has evolved out of an exploration of characteristics of the material.

The next examples (picture 18, 19) show the results of a study of the structure of joints of square posts. Since in architecture or interior design, posts made from plane materials like aluminium are often used, experimented with the way of joining the posts of paper in space. If one develops a method of skillful joint of the post making use of the characteristics of the material, it will have wide application. That is the basic exercise.

13



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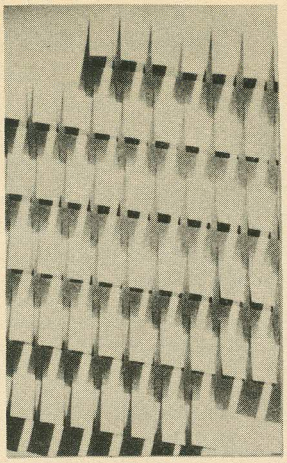

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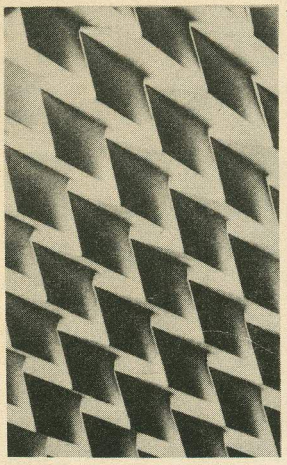

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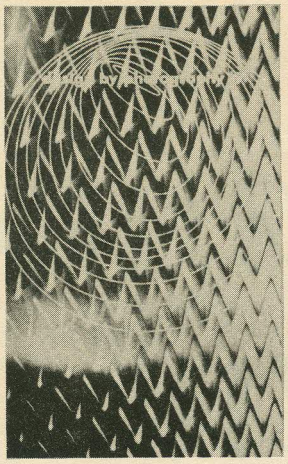

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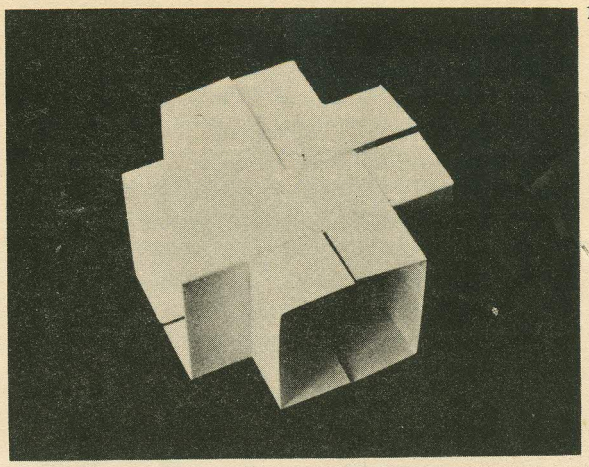

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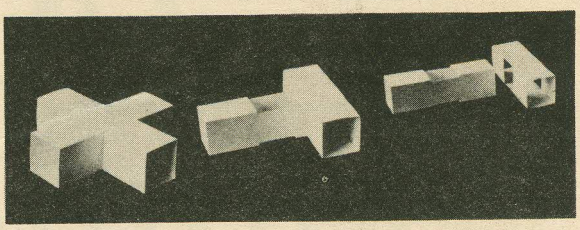

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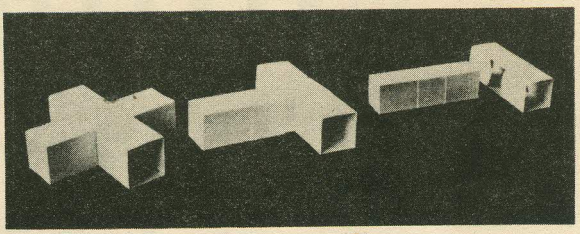


So there are many kinds of Kohsei in the three dimensional space, and each of them is useful for studies in fine art and design.
Conventionally, most people think of Kohsei or 'Basic Design' as meaning practice for beginners in Art and Design, to get accustomed to the work of creating. Just like the sportsmen doing some warming-up exercises before starting the main play. But now Kohsei as basic Art and Design has come to be regarded as an independent special field of science, much as any other basic science. (Basic Medical Science, Basic Engineering Sciences and Basic Law etc.)

Also Kohsei extends from beginner's level to higher levels of studies about form like higher mathematics, electronics etc. So that, in this field also, besides the "Kohsei in three-dimensional space" mentioned here, there are "Kohsei in two-dimensional space", "Colour Kohsei" "Kohsei by Light", "Kohsei of Movement" etc. Each of them include the contents of "Visual Kohsei" and "Functional Kohsei".

The main feature of the example given is that it is inserted by using the flexibility of the material. But the structure once its fixed is difficult to take off. This is not an example which aims to express the beauty, but it solves the structural problem of connection of the post. So we can call the construction of this form as a "functional kohsei". On the other hand in the earlier examples, the main effect is visual, especially an expression of beauty, & so we may call it "Visual Kohsei" as opposed to "Functional Kohsei".

A study of Kohsei, prepares a student to do creative work as an artist in many different media, and with greater understandng. In Tsukuba University a four-year course in Art & Design, specializing in Kohsei is available, corresponding to the undergraduate course of the general university. In addition Master's and Doctoral level courses in Kohsei are available in the Graduate School of Art & Design, and are open to students who wish to pursue higher level studies in Kohsei. Since the foundation of the Kohsei course in Tsukuba, over 50 students have graduated with specialisation in 'Kohsei'. Most of them have become teachers and designers. The designers are working in diverse areas like graphic design, jewellery design, package design, display design etc. ■

# A Humanistic view of Things

– K. Munshi

अभिकल्प

**Man and Machine**

Till now the ergonomics or human scientists have only reacted to the already designed products or man-machine situations. They trend to study these situations in depth and come out with recommendations which become obsolete soon enough, because the technology changes are so fast that product configurations become entirely different from what these were when the studies took place. This is particularly true of computers and VDTs and other electronic data processing equipments. Classical example is integrated key board with screen. It was only after thousands of such units were made that ergonomists realised that it is best to separate them. How long can we keep on making mistakes and correcting these and in the process of correction generate new set of problems? Would it not be better to look for a correct solution in the very first place?

If human being is at the centre of the man-made universe, the machine configurations/ physiognomy should be dictated by the qualities of use and usefulness to the human being. Ergonomist or the human scientist should be able to dictate the way in which the technology should be led. It is now time to control technology. Technology should be pushed from being the master to the position of slave. There is enough known about it and enough known about how to manipulate it.

**Liquid in Pot Model**

Previously the product form or physiognomy of a product used to be dictated by the sizes of the components, mechanical linkages between various components and their physical interference or fit. But with the large scale use of micros & LSI's the technology has become physically pliable. There is very little or no constraint offered. Electronics has become like a fluid.

Electronics in fluid form is going to be a very important commodity for the human being. Like water which is a useful commodity, it will be used in various modes. But its usefulness will be totally dependent on the form of the container or pot in which it is placed. For example if the water is to be drunk, it has to be kept in a glass or tumbler and if it has to be poured, it is kept in a jug with a spout, if it is to be carried on head or hip, the pot takes the shape of round bottomed, narrow mouthed vessel and so on. Similarly electronic components placed in suitable 'pots' perform better in situations for which the particular shape of the 'pot' is considered, as it is the shape of the 'pot' which interacts with people.

The technology can be taken for granted. The real limitations on design will be human capabilities and limitations. So the major design criteria in future will be human criteria. For example it may be possible to make a watch within a flat plate of 5 mm square or even less, but the use criteria has to prevail as the digits of this watch are to be seen from a certain distance which necessitates that the digits should be only "so" big. Nobody even in future would like to carry such a small watch where he is forced to see the time from a distance of 10 cm or less.

Similarly in video display terminals screen may become as small as one wants, but the character dimensions cannot go below a certain limit (which has to be very very comfortable) again to be dictated by human considerations.

In fact it is now the duty of the human scientist to take the lead and show the directions in which the technology or products of technology should be made so that these become more useful, more meaningful and more friendly to the ordinary user.

**The Slate Model**

This envisages that the future interactions with computers will be like the school boy's interaction with the slate. The computer terminal (the display and keyboard) should behave like a slate.

You have pointer (chalk) and you have a slate (keyboard and screen rolled in one) or you have one slate for writing and another for display. To try out a simple calculation - write ( 2 + 4 = ? ), the question mark should vanish and answer 6 should come out ( 2 + 4 = 6 ).

In a graphic facility, draw a line in free hand, it should be reproduced exactly or in the modified form as commanded,on the display slate. Write the length and the line should become that length. Write the angle and it should be tilted to that angle. Draw a circle by pointer on the command slate. Write r = 15 cm and machine should draw a perfect circle with radius equal to 15 cm.

The communication between man & computer should be like between master and slave and naturally in the masters language. It has happened all along and it should happen in future. The only difference should be that the slave has been replaced by the machine.

The command slate has to be flexible like a sheet of paper on a thin writing clip board or rather it should be like a slate - put it on the lap

or put it on the desk or on the floor - wherever it is convenient. Or have the command and display slate as one unit with one surface. The matter should get erased with the rub of the hand - just like in a slate so that you can write again.

The programming for such kind of software may be very complicated, but that should be the aim. If this model is presented to the engineers, it is certain they will come out with it in the near future. The technology is available and it has to be refined and used universally.

### Written Dialogue versus Oral Dialogue

Many animals, mammals and insects too communicate orally. Writing is the form of communication which is special to the human being. It has taken us centuries to develop this capability. It is superior to speaking and reading ability. It takes longer to learn in any language, and man is considered literate and more civilised if he knows how to write. It will continue to be so in the future also, as it will take us many centuries to undo this notion. Let not the present generation forget writing as many advocate; and be gullible enough to fall into the machine trap (oral computer) and lose for ever what has taken us the ages to develop, for in the future nobody knows whether the computer in the existing form will hold the sway or will be made obsolete by some other fantastic gadget. Think of the Slide Rule - no scientist or engineer could do without it, and now it has completely disappeared and very few even know the name.

Let oral communication be used between man and man and more formal written communication between man and computer. How would one like to be heard talking to a tree or stone or for that matter to a computer (an innanimate object after all)? How would it be if in computer terminal room, everbody is murmuring to the computer? Let oral communication be limited to specialised areas and for people who have the kind of handicap which prevents written communication like the blind or the paraplegic etc.

### Keying versus Long Hand-Writing

With the severance of physical connection between the type-head (printer) and the keys (key board) a whole new area, (modes of usage) have opened up. Keyboard, which is a hangover from the past (from traditional mechanical typewriter) has the possibility of being dispensed with, atleast partly.

It is now possible to store various type forms in the memory of a computer and compare the text written in various type forms on the display slate. The keyboard may now be kept aside, instead using the command slate on which one may write in long hand and get the display and print in any typeface and size one wants.

This raises the question of efficiencies of keying vis-a-vis long hand writing.

Many claim that keying is more efficient than writing. But keying is efficient only:

1. If the person using keyboard is highly skilled and proficient, which means special training in these skills to be imparted to everybody. The costs are enormous both in terms of productive time and infrastructrure development.
2. If it is plain typewriting from a copy, which in most of the cases is in hand written or a hand corrected type written draft. Duplication all the way! If the person has to "think and key" then keying efficiencies drastically reduce because of the inevitable corrections where the process of search gets involved. This is generally ignored in efficiency calculations. Think and write process is overall efficient for drafts where the insertions and erasing is very frequent.

While writing, erasing can be done with one stroke which is not possible in keying. Insertions are even more difficult and time consuming with the keying process. A blend of keying and writing needs to be evolved for overall efficiency of the system e.g. Pressing an 'ON' key is more efficient than writing 'on' on the 'slate'.

### Home Computers vs. Personal Computers

Computers were miniaturised and further maniaturised till they became very compact - small and cheap enough to be affordable by an ordinary family. These became personal computers. At present there is no difference between a personal computer or a computer for home or a small computer for office. These small machines are marketed as both. There is a basic difference between the two which has not been recognised or it has been deliberately ignored.

A home machine has to be a multi user device with varying personal characteristics of users as in a home you have children of various ages, adults, old people. Their requirements are also variable. The present machine is a single user device. The most it can take is two users at a time.

**Grey-board Model**

A home machine should have a big screen so that it can be watched by a whole family of six or eight people. It should be like a "Black Board", or a "White Board" or literally a "Grey Board" - put it on wall or a table with an assortment of command slates which can be plugged to it by various users for simultaneous use or otherwise. Standard commands including standard key board should appear on the grey board or slate and be operative with a touch, thereby achieving an optimised use of writing and keying to enhance the overall efficiency of the man-machine system.

**Oral Arithmetic Vs. Calculator**

Lot of scientists are reconciled to the idea that with more and more use of electronic compact calculator, oral mathematics/arithmetic should take a secondary place. Oral mathematics/ arithmetic is a mental skill which can be easily learnt upto a certain level or complexity. In the interest of overall efficiency of the calculation process a judicious use of both (oral arithmetic and calculator use) is required. For example, if one has to calculate 2 multiplied by 6, oral multiplication tables can give an instant answer whereas use of calculator for the same calculation involves extra motor and perceptual faculties and is therefore much more time consuming. On the other and a calculation like 24 multiplied by 39 can be done more quickly by calculator than orally. Oral calculations upto a limit should and need in fact be encouraged particularly among children as increased and constant use of mental faculties in any form (one such form is oral arithmetic) improves these faculties, rather than otherwise.

**Cultivated Handicap**

Any dependence on a thing other than one's body and mind is a handicap. So the effort of any human scientist who is involved in the design of hardware or software for human use should try to minimise the incidence of any sort of handicap that one is likely to acquire.

Dependence on calculator (external gadget) for all kinds of calculations is a handicap. Many persons would try to compare the use of calculator with the use of pen as in future they think calculators are to be used like pens and why not? But then the use of pen is also a handicap in a way as you cannot write without it. If you do not have a pen with you, you cannot write the new telephone number of a friend to whom you are talking from a public phone. To circumvent this handicap you try to remember the number. If you use your mental faculties of memory as much as possible and if you are trained better, your dependence for such small notes will be less and therefore you have less handicap and so a "superior life".

So far we have maintained a proper balance between the use of our tools like writing instruments and alternatives within our system, but now our external tools are becoming very powerful and if we have to maintain the power parity, between the man and the objects around him, we have to increase our own powers and skills to match, so that we are not left high and dry if these external props to life are withdrawn.

So let us not forget these skills; let our children learn such skills and more such ones which will make them independent from the external gadgetry. One such good example is heart pace-maker which used to be outside the body. It was a bulky unwieldy gadget, which could easily get knocked off. It has been reduced in size and is now being implanted in the body. It has become part of the body, so it is less of a handicap than it used to be previously. Another example is soft contact lenses, which have also become part of the body.

So if we have to be dependent on calculator, let it be implanted and be part of our body. And till that time when everybody can implant a calculator, let the oral arithmatical skills be taught and be used.

Another argument against the above is that instead of using or taxing the brains by remembering tables of multiplications, children should be taught more creative work. This "or instead" business implies that the power of mind or brain is limited. This assumption has however been shattered by many who have proved that full potential of human brain has not been realised as yet. So there is no question of "instead". We can always use "and" - learn more arithmetical skill and do more creative work.

A wise management always tends to keep alternative suppliers for crucial parts or services to ensure that their production goes on if one source fails. Standby power generators are kept at high cost, just in case the main supply fails.

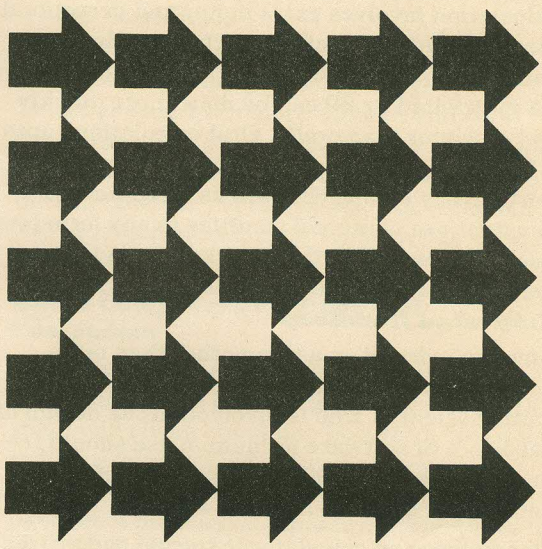
Similarly to lead a full life, a life of freedom and independence we must always keep alternatives available within ourselves, however crude or inefficient. We must therefore use a proper blend of our internal physical and mental powers and external conveniences and tools so that total efficiency of the man-machine system is maintained at a high level under varying circumstances. ■

# NOTES ON VISUAL RELATIONS

**RAVI POOVAIAH**

Presented here are a few sample charts and summary of different syntactic features identified as the basic elements or principles for visual representation. The visual features can be compared, related and analysed in relation to their variability. This kind of an exercise lends awareness of the extent of their possibilities and limitations and can act as a framework for understanding the basics of a visual knowledge. Also, we learn more about the visual through changes and transition than through single images. These charts are an extension of the idea that a visual representation is perceived as a whole and parts of it are always perceived in relation to its other parts.

This analytical way of comprehending the basics of visual representations can generate a methodology for basic visual design education.



**Acknowledgement**

Thanks are due to Prof. David Manzella of Rhode Island School of Design, and also to the staff of IDC, IIT, Bombay and Rhode Island School of Design, Providence, USA, for having helped me in this project.

**Visual Elements**

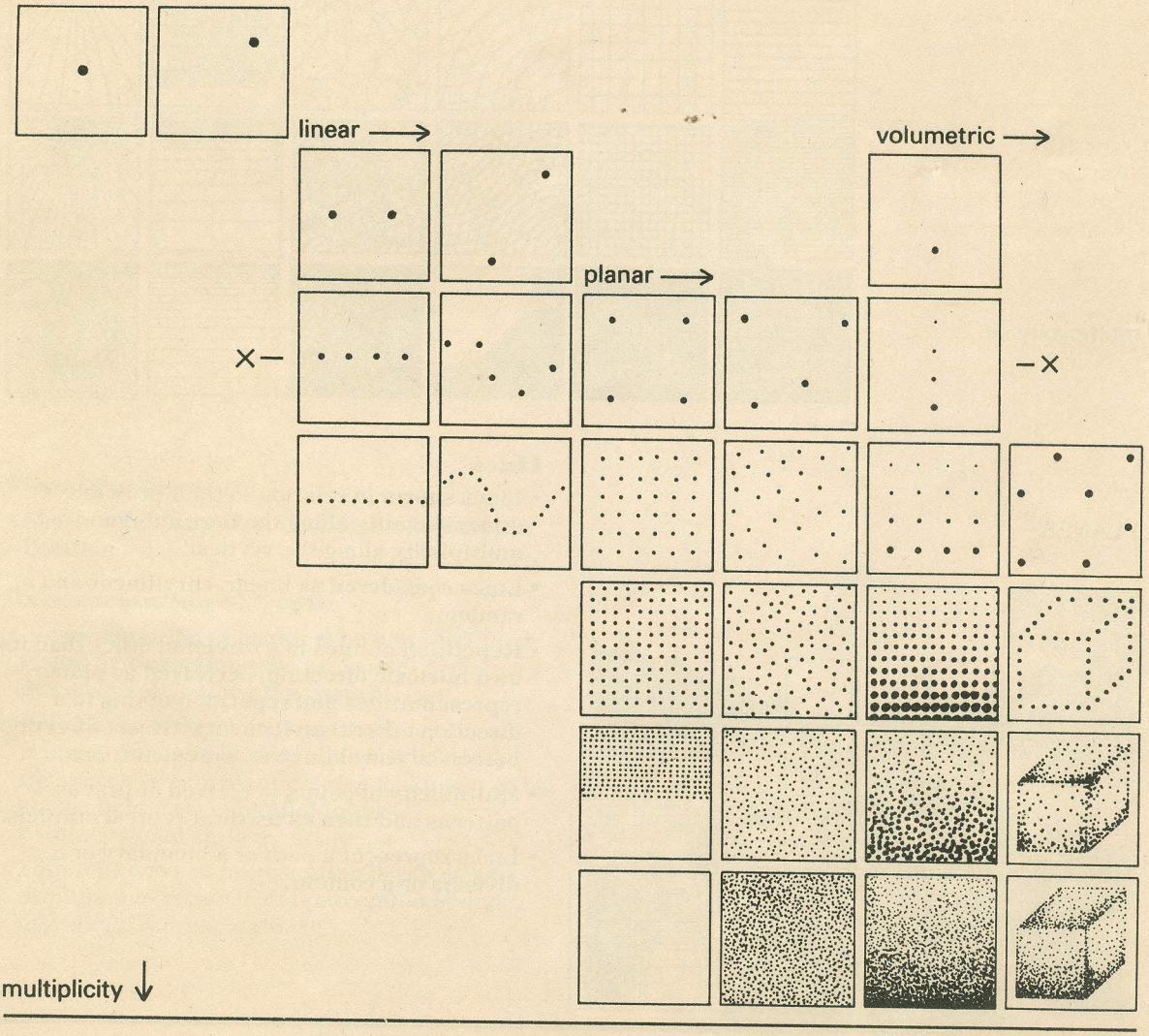
- Points
- Lines
- Planes and
- Volumes

**Points**

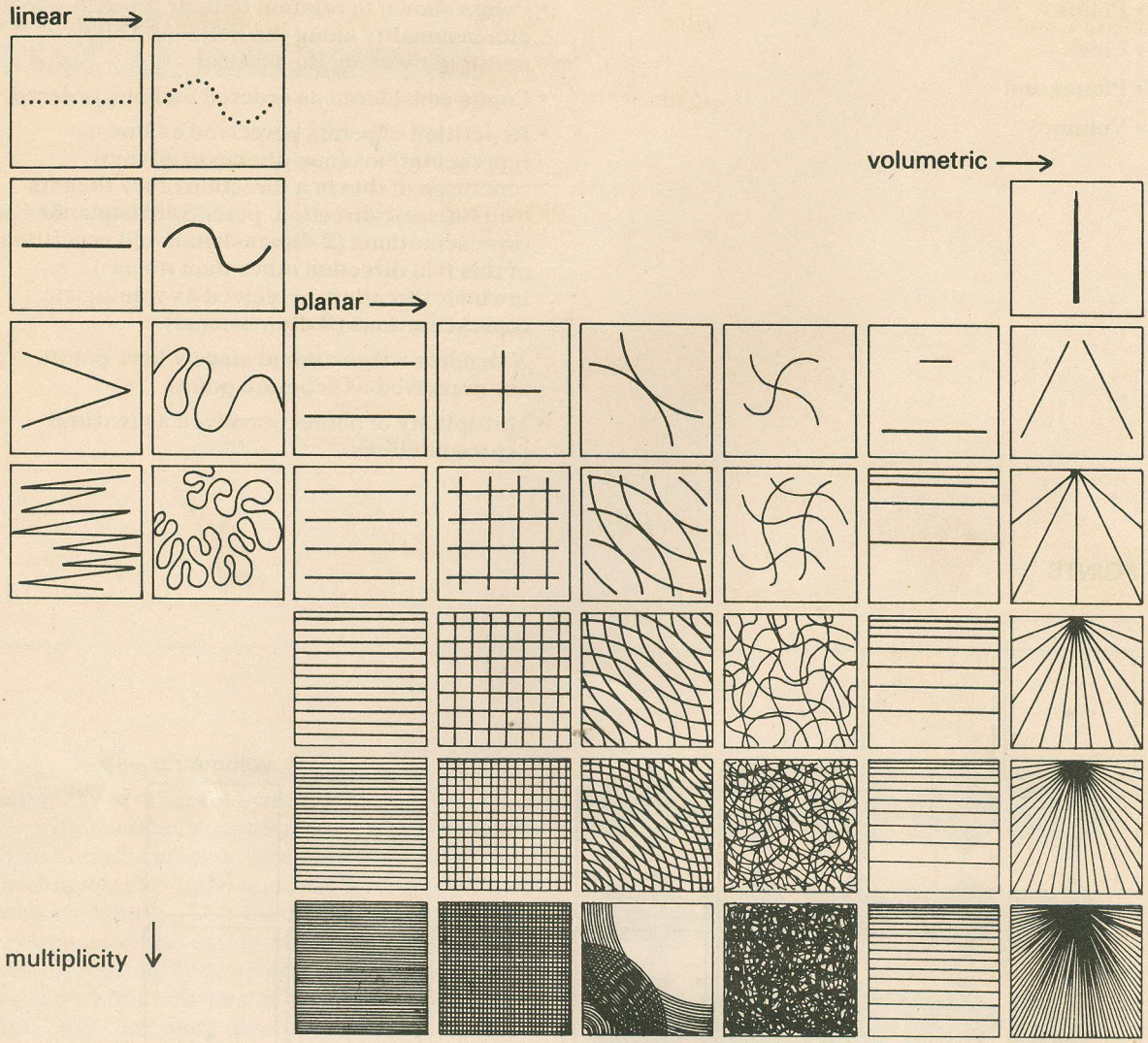
- Points shown in relation to their growth-dimensionality along the horizontal and multiplicity along the vertical
- Points considered as ordered and non ordered.
- Repetition of points perceived as linear representations (one dimensional) and repetition of this in a direction other than its own intrinsic direction, perceived as planar representations (2 dimensional) and repetition of this in a direction other than its own intrinsic direction, perceived as volumetric representations (3 dimensional).

  X denotes a transitional stage where points are perceived as seperate points
- Multiplicity of points perceived as textural representations.

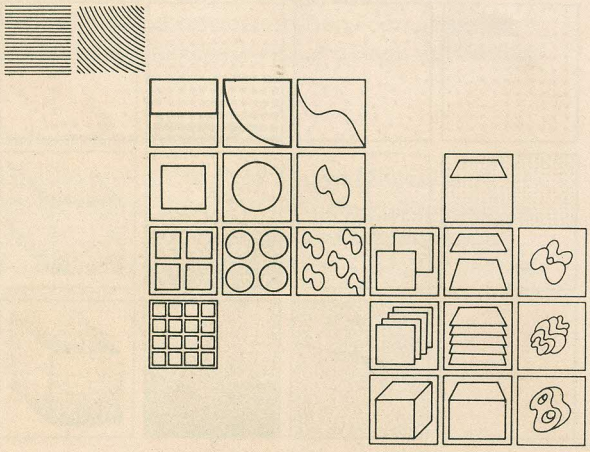
POINTS



## LINES



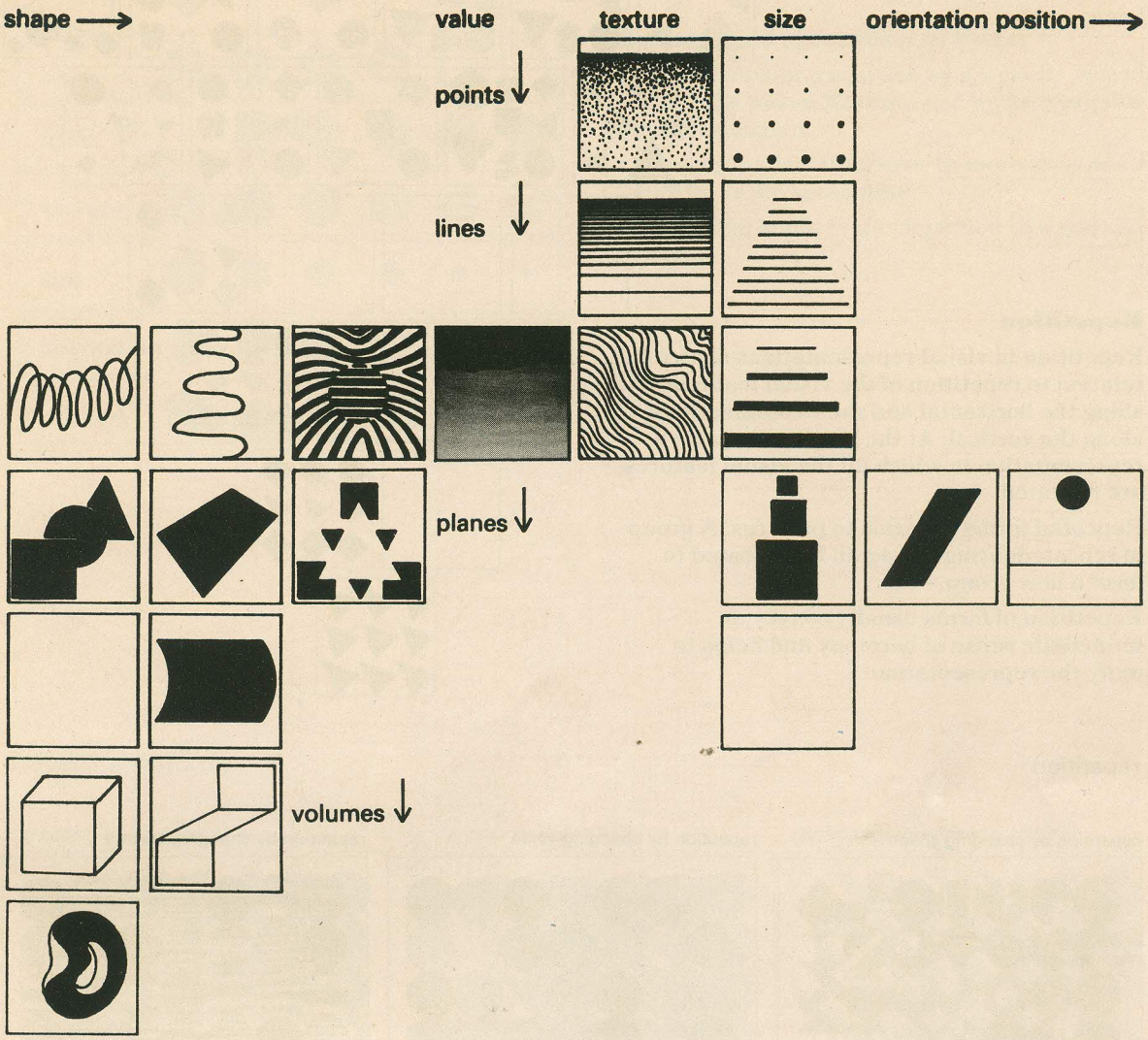

## PLANES



### Lines

- Lines shown in relation to their growth - dimensionality along the horizontal and multiplicity along the vertical
- Lines considered as linear, curvilinear and at random
- Repetition of lines in a direction other than its own intrinsic direction, perceived as planar representations and repetition of this in a direction other than its own intrinsic direction, perceived as volumetric representations.
- Multiplicity of points perceived at first as patterns and then as textural representations.
- Lines represent a path or a boundary or a division or a contour.

## REPRESENTATION OF DEPTH



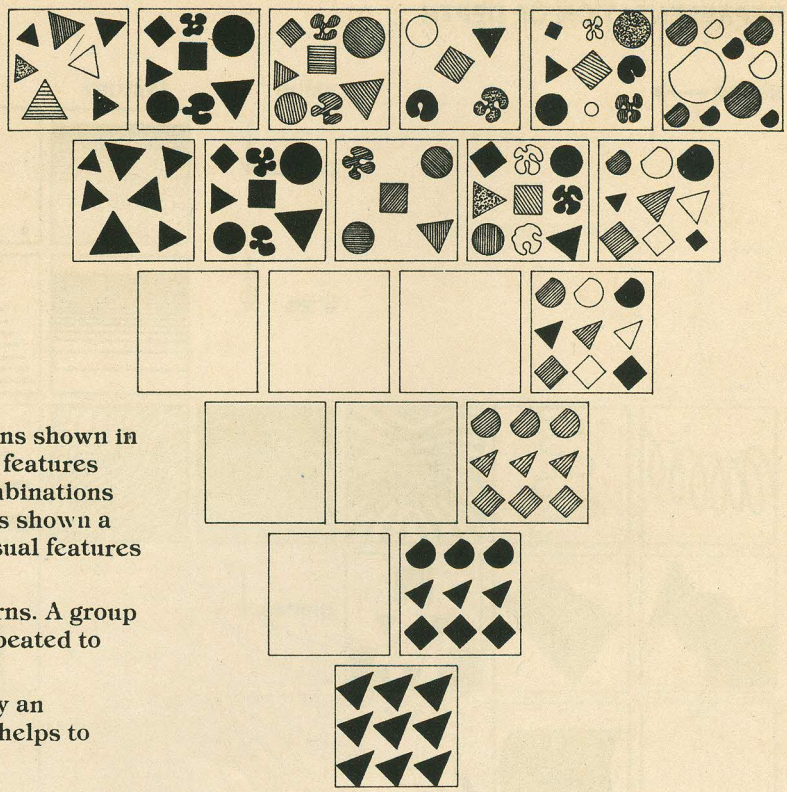

### Visual Features

• Shape • Value and Colour • Size • Orientation
• Position

### Representation of Depth

- Representation of Depth shown in relation to visual features along the horizontal and dimensionality along the vertical.
- Perception of depth in two dimensional representation is illusory. Because of spatial illusions, the representations may appear to be above, below or unparallel to the 2-dimensional surface.
- Different ways of representing depth can be combined to enhance the perception of depth in a single representation.

REPETITION

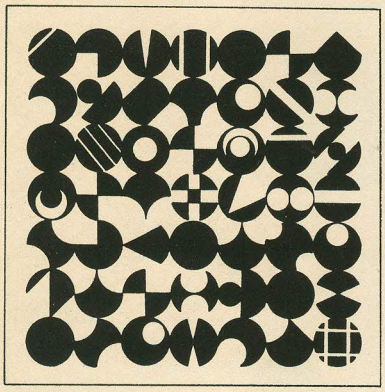


**Repetition**

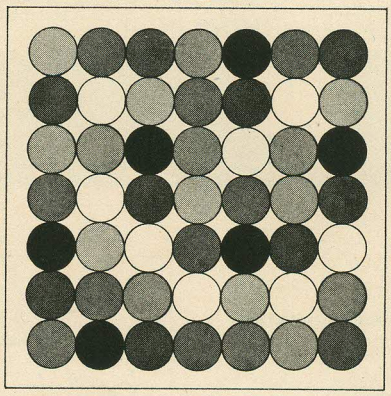
- Repetition in visual representations shown in relation to repetition of the visual features along the horizontal and their combinations along the vertical. At the bottom is shown a representation in which all the visual features are repeated.
- Repeated forms give rise to patterns. A group of repeated forms can again be repeated to form a new group.
- Repetition of forms usually convey an immediate sense of harmony and helps to unify the representation.

repetition

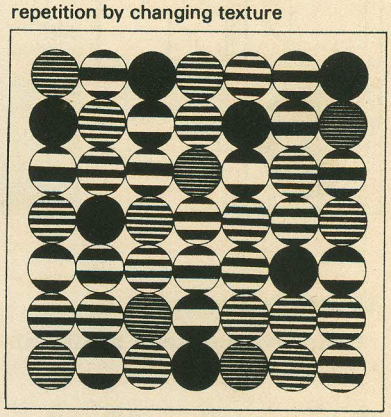
repetition by changing shape



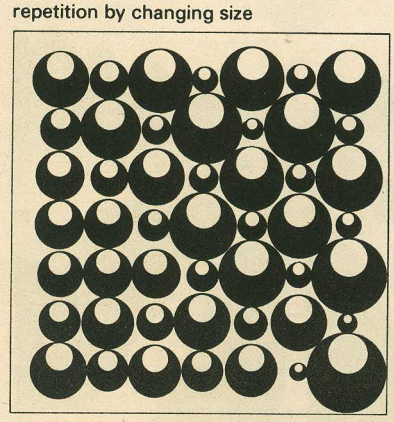
repetition by changing value



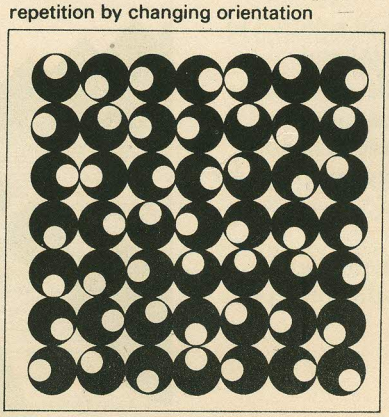
repetition by changing texture



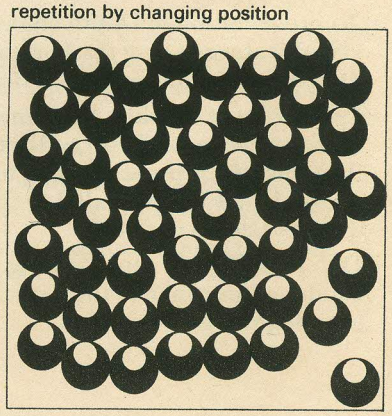
repetition by changing size



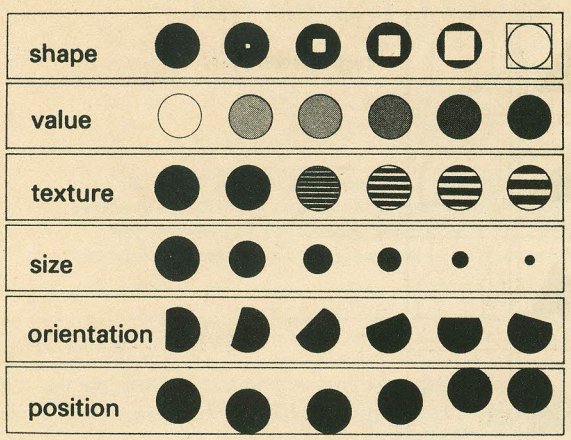
repetition by changing orientation



repetition by changing position



## GRADATIONAL REPETITION OF FORM



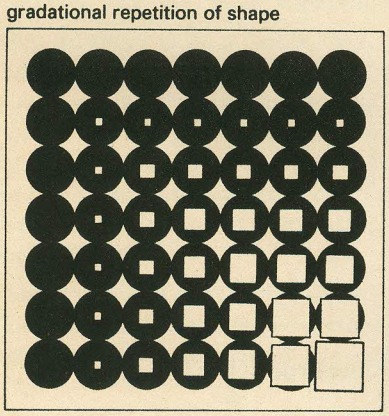

**Gradational transition of Form**

- Form shown in transition by gradually varying one of the visual features and by keeping the others constant.
- Transitions can also occur in more than one feature at the same time.
- Transition leads to the depiction of a gradual change.

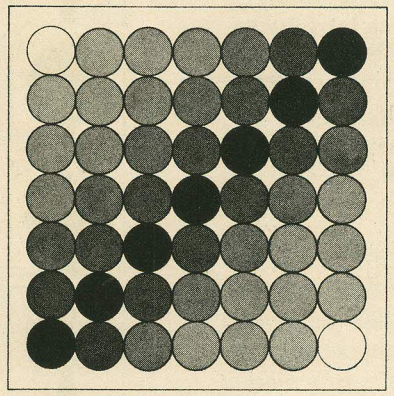


repetition of forms

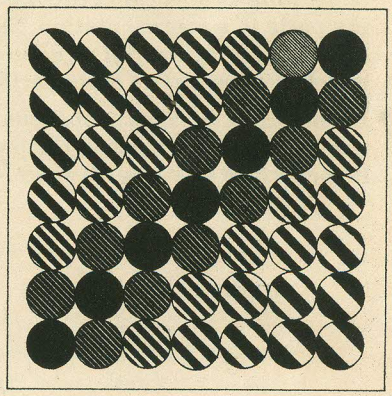
gradational repetition of shape



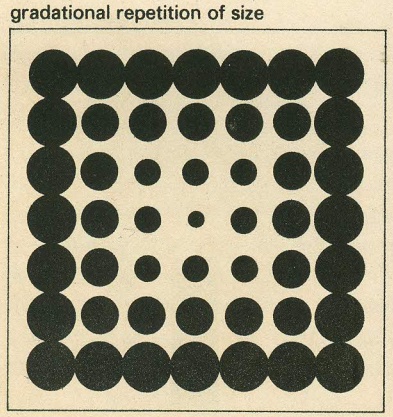
gradational repetition of value



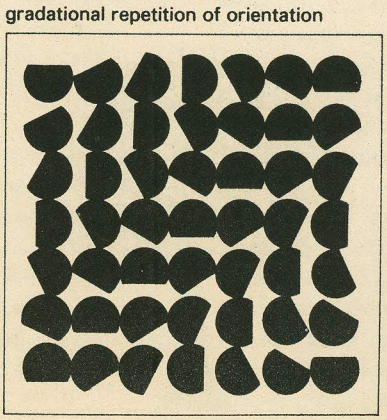
gradational repetition of texture



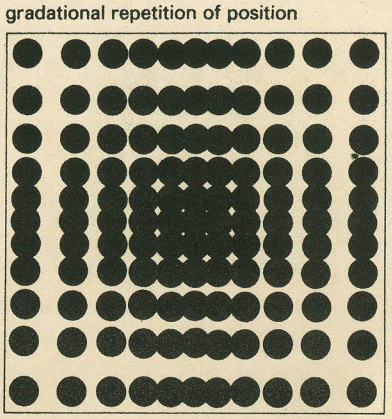
gradational repetition of size



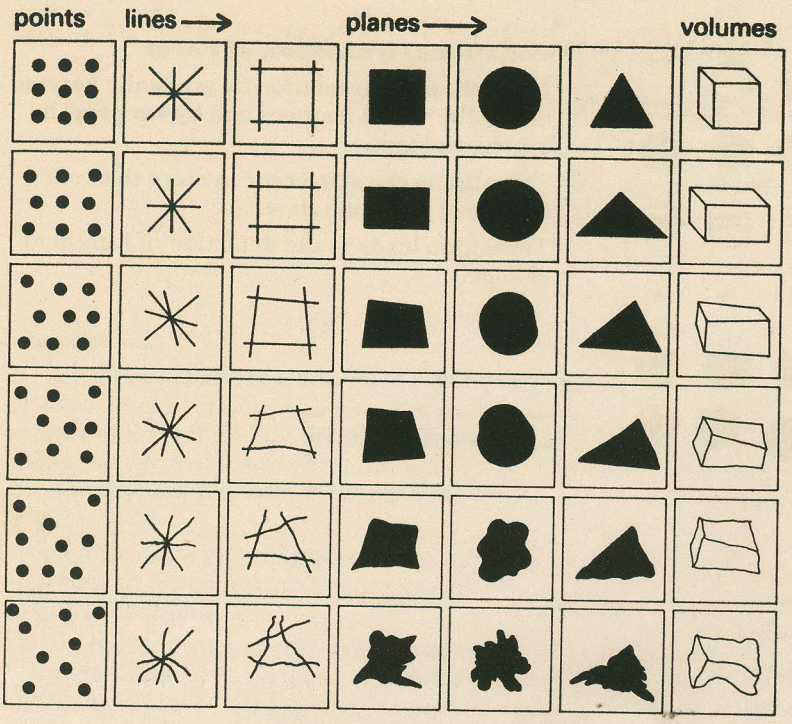
gradational repetition of orientation



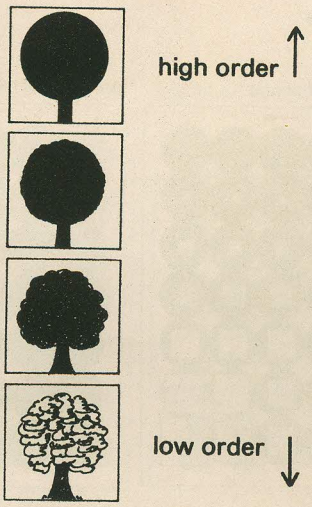
gradational repetition of position

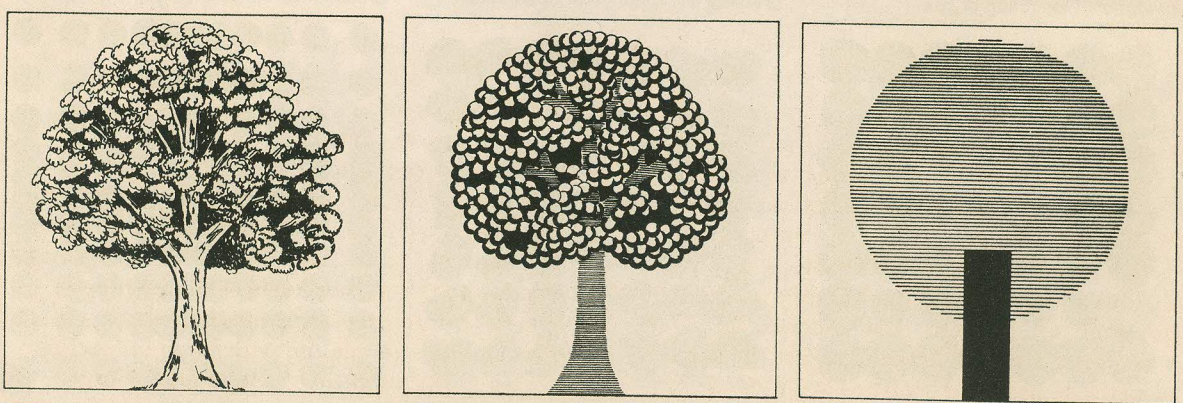


## VISUAL ORDER




- Order shown in relation to dimensionality along the horizontal and the degree of order along the vertical
- Visual order refers to the degree and the kind of lawfulness governing the relations among the parts in a representation. Such lawfulness comes from the overall structure as a whole to which the properties of its parts must confirm.
- Highly ordered representations denote simplicity, co-ordination, regularity and may be perceived as being abstract. ■



# On Golden Things and Other Meanings

**GUI BONSIEPE**

(Prof. Gui Bonsiepe of the Institute for Industrial Design, Florianopolis, Brazil spent 3 months in India recently as an UNDP consultant to the National Institute of Design, Ahmedabad advising in the formulation of the 'Science and Technology Inputs' in NID's curriculum. This thought-provoking piece resulted when 'Abhikalpa' requested Prof. Bonsiepe to write about his impressions of design and design education in India.)

## A discussion at IDC

These are not travel notes; but short comments on design ephemera in India. They have been written during the last two days of my fourth visit to this country. They are polemical, contradictory, unsystematic, unpolished; like sketches. I have preferred to leave them in their rough form. Kirti Trivedi has asked me to resume the points of a discussion we had during a 2-days meeting at the IDC in January '86. Unfortunately, the exchange of opinions has not been tape-recorded. I remember several topics which have been brought up. I take them as startings points for personal reflections.

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## Design "in" or "for" developing countries

Should there exist a Noble Prize for stupidity, he (or she) who invented that arrogant and discriminating term "developing countries", would certainly stand as a serious candidate for consideration. Nevertheless, the term, born out of a parochial perspective, continues as semantic currency in international debates and publications.

The term "Third World" I don't like either. It has too many emotional overtones. It presupposes a unit which in reality does not exist.

So I stick to the (not less controversial) term "peripheral countries", because it is that characteristic which constitutes their reality: they are rather objects than subjects of their history.

I assume that there are two designs today in the world: the design in and for the central countries, and the design in and for the peripheral countries. Both have rather little to do with each other. The differences in context, the differences in outlook, the differences in problems are so great, that sometimes I wonder whether it is not misleading to use the same term for so different realities.

To the design community in the Centre, this may not sound agreeable. And one must understand it. A scheme of thinking which takes as point of reference the triangle Europe/USA/Japan (suggesting that that is the area where the "hot" things are happening in design), will experience slight discomfort when confronted with realities which do not fit into that scheme. Suddenly, its absolutist attitude becomes undermined, eroded, relativised.

Recently, somewhere in Europe a well-meant design seminar had been organised, or planned, sponsored by not less well-meaning organizations, and inspired by not less well-meaning good intentions, on nothing less than health equipment for developing countries. I wonder, when the day will come, when finally we do no longer design "for" the Periphery, but "in" the Periphery. In other words: getting things done in the real context, moving towards self-reliance in design, overcoming the limitations of "aidism."

●●●●

## "Indian" Basic Design

One of the great innovations in modern education, has been the "basic course" or "foundation course" invented by a group of people at the legendary Bauhaus at the beginning of the twenties. Improvements have been made since then, modifications, revisions; even the dissolution of the basic course as a pedagogical unit has been proposed (and practised e.g. in the Ulm School for Design). The intentions of this innovation can be resumed as providing the student with a grammar of form, with general design tools for handling specific design tasks later on, with a "vocabulary" or an "alphabet" of form to create words and texts. Emphasis has been laid on syntax training, isolating aesthetical phenomena and dealing with them in so-called not-applied exercises or assignments: studies in

colour, textures, composition, surface transformations, grids etc. The dimension of meaning has been put into brackets, or quarantine.

I have been told that Indians see reality as full of meanings, almost overpopulated with meanings (for the puritanic mind). If that self-characterisation is true, Indians seem to invest objects with meanings. As a consequence, a basic course should try to incorporate the semantical dimension. That is a challenge design educators face. It would really break some new ground in design education.

●●●●

**Design in general education**

Primary and secondary education, and tertiary education to a good extent, are basically castration devices to deprive children and students of their creativity. We would be well advised to expect only marginal improvement of design education on tertiary level, as long as primary and secondary education continues with its dominating paradigmas of what is to be considered "intelligence". In that system, design capabilities are frankly discriminated. An evaluation system which awards rather the capacity of memorizing answers, than question answers, an "exclusivity syndrom" of training which only trains discursive intelligence and neglects the forming of non-discursive thinking (and doing) in the child, cannot expect better results than those we are facing to-day. The aesthetical monstrosity of our man-made world has its roots in education. There, almost everything is wrong. Education will have to be re-thought. Otherwise, the basic course will remain what it is today: a therapeutic course for repairing some of the damages inflicted to students before they enter university education.

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**Architecture and Industrial Design - a basic difference**

Some architects and theoreticians of architecture are fond of the idea that architecture and industrial design are more or less the same and that they can be put under one cover (of architecture, of course!). Some even go further and declare that due to his general cultural formation the architect is qualified to do industrial design, and that specific industrial design training is not necessary. I don't share this opinion.

There is, to my mind, an essential difference between architecture and industrial design. Architecture has to do with the articulation of space, whereas industrial design has to do with the articulation of functions. The architect's concern is the habitat; the designer's concern is the object that is used within that habitat. Those are quite different perspectives.

If there would be sufficient building tasks, i.e. financed projects, architects would probably prefer to stick to their main task: design buildings. For that there are trained. In that realm lies their unsubstitutable contribution.

Industrial design may be many things, but surely it is not architecture, neither in big nor in small scale.

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**"Hot-house" design**

Memphis Design does not want to be considered as part of post-modernism. And rightly so. It started a rebellion against the "usefulness" of products, or better, a particular kind of products: those for interior decoration/equipment (lamps, book-shelves, tables, beds, sofas, side-boards, ceramic products). We still have to wait for an agricultural machine a la Memphis.

It stands up against the canonisation of modern design standards of so-called "good" design (incidentally, a moral concept, and not an aesthetical concept). It favours the ephemeral, instant consumption, temporariness - nothing definite. It is not interested in "function" (whatever that means), but in "communication" (whatever **that** means). As a consequence, it is not interested in technicalities - these are pedestrian concerns, too modest, too little "inspiring", too little "jazzy". Thus, Memphis' brillance in experimentation with aesthetical codes, is matched by technical conservatism. Its attraction on design students may lay less in its visual glamour, but in the fact that it promises instant gratification (don't bother about the details, for that dull task you have your technicians at your disposal). How seductive it is, to indulge in commitmentless scribbles-sketches.

Memphis seems to me less a symptom of vitality, but of utmost despair about marginalization from industrial production. It's a reaction against the tedium of over-saturation. It's a phenomenon for the rich world.

**Design - 'Made in USA' and 'Produced in India'**

I asked Indian design students and designers what they thought about the design exhibition organised in the framework of the Festival of India. Some of them were dazzled: 'That's it! That's the jet fuel to be catapulted into the international design arena'. Others were more skeptical. Nobody would question the organizational talent that went into that event. Nobody would doubt the professional efficiency in getting things done. Nevertheless, some confusion might result, because of an almost inevitable association of design with the needs of dollar millionaires. Design for a consumer elite which can entertain their guests in a party tent painted by local Indian craftsmen, Design for a consumer elite which can offer a seat on a stone-carved-sculptured bank, Design for a consumer elite which can huddle nice little textile toys - designer designed toys.

Do the high skills of the Indian craftsmen deserve the foreign designs (as one invited celebrity formulated it), and/or do the foreign designs really always match the quality of the Indian craftsmen? Perhaps yes. But, that's not the point (though the design quality of, for example, some stone tableware might be matched without major difficulties by any second year student of ceramic design in India).

The point is, whether the Indian craftsmen get some benefit from putting their know-how at disposal of foreign, though famous, designers. The merit of that exhibition consists - according to my view - in having put the question "Design and Crafts" onto the table. That is a question an Indian designer must face. A right problem has been stated; the answer, however, seems to me wrong.

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**Engineering and Industrial Design**

That is a two-sided love story.

Generally, industrial designers feel somehow insecure compared to engineers who are supposed to know, and sometimes really do know more about technology. In industry, it is probably the engineer who gets more credit than the industrial designer, at least at present, though that may change in the future. Design still is a marginal element in management, and only occasionally accepted on its own terms.

But after all, these axiological questions are not interesting. I think, however, that engineering education as far as design is concerned needs to be drastically revamped, in order to overcome its present crisis. As one group of engineers phrased it:

"It is time that the basis of engineering design education be re-examined. The influence of scientific reductionist thinking has led to predominantly analytical modes of thinking in tertiary engineering courses. Staff have been recruited mainly from within the university or college system, having added scientific postgraduate training to their science - and mathematics - based undergraduate qualifications. Thus the engineering education system has become closed and self-reinforcing, and the modes of thinking and attributes to which young engineers are exposed have become further and further estranged from real world tasks and responsibilities." (J.E. Holt, R.F. Radcliffe, D.Schoorl, "Design or problem-solving - a critical choice for the engineering profession." In: **Design Studies,** vol 6, nr. 2, April 1985, 107 - 110).

One can hardly not agree with this diagnosis. I think the moment has come to invert the question of engineering input into industrial design.

Industrial design input into engineering education can have a vigorising effect.

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**Death declarations of rational design**

I wonder whether all these frequent death declarations of functionalist and rational design - so en vogue today in self-proclaimed avant garde circles - don't fullfill the function of a tranquiliser.

In front of the return to the intimate, and self-proclamation of the "I", a rational design approach might ask some uneasy questions.

"Functionalism" and "functionalist" design have become negative catch words. Critics can attach to them everything they don't like in modern architecture and design, staging as the defenders of "real" human needs.

If a famous architect says, that post-modernism is the attempt to connect again these theoretical and stylistic bonds which advocates of modernism have cut, then one might correct:

Modernism does not connect, it sets radically new things. One cannot have it both ways: You are either modern or anti-modern. That is the only alternative. ■

# Thinking about Design

**GUI BONSIEPE**

(A review of the book: **Understanding Computers and Cognition: A New Foundation for Design** by Terry Winograd and Fernado Flores; Able Publishing Corporation, Norwood, New Jersey, 1985)

The domain of design theory is dry like a desert. There are very few points of reference, and so far only a handful of books exist that would deserve the qualification "relevant for a future theory of design". This fact is both upsetting and amazing, because design is one of the central modes of human relatedness to the world, such as the use of language.

The authors have changed this rather desolate panorama. Terry Winograd is a computer scientist involved with artificial intelligence at the Xerox Palo Alto Research Centre; Fernando Flores from Action Technologies in San Francisco has kept post as Minister of Economics and Minister of Finance in the government of Salvador Allende in Chile, and is heading today a team of software developers for management activities.

Their combined efforts have produced a book which asks fundamental questions about computer technology, the nature of language and thinking, artificial intelligence, management and design... It opens completely new avenues to understand design as an ontological equipment of man - design that provides the basis for branching off in different disciplines, including architecture, industrial design, graphic design, urban planning, engineering design, and systems design. In other words, we deal with a fundamental book, a book that often dissolves problems rather than solving them.

As with any new fundamental approach, existing orthodox bodies of thought are scrutinized and criticised; especially the tendency, prevalent in the 60's to equate management (and design) with problem-solving; the pop-iconography of the computer as a "thinking" humanoid entity; the rationalistic tradition which regards language as a system of symbols arranged in pattern that stand for things in the world (the so-called 'correspondence" axiom).

However, this critique is not to be characterised with the label of what on the continent has been known as "Zivilistionskritik" (romantic antimodernism and thus antitechnological bias); on the contrary, the authors express their commitment to develop a new ground for rationality, in which reason (Verstand) would be interwoven with wisdom (Vernunft).

At first sight it might seem strange that a book addressing philosophical questions of cognition, speech acts, semantics, perception, hermeneuetics, ontology, semiotics assigns such fundamental importance to design. However, the following quotations might explain the reason for this decision.

> "In order to understand the phenomena surrounding a new technology, we must open the question of **design** - the interaction between understanding and creation. .... We address the broader question of how a society engenders inventions whose existence in turn alters that society. We need to establish a theoretical basis for looking at what the devices do, not just how they operate." (4)

Design would be the bracket between contemplative thinking (understanding) and innovation (action/creation). Whereas technical descriptions of new technologies (tools) limit themselves to the enumeration of operational attributes cutting off these objects from the user - and his interests, and thus needs -, a more radical approach asks: what are people **doing** with these tools, and what **can** people **do** with these tools ?

> "We encounter the deep questions of design when we recognize that in designing tools we are designing ways of being" (XI)

This phrase reveals the reason for considering design as a fundamental category. Because it is through tools that man not only relates himself to world, but constitutes world; tools not to be understood as operative medium, but as constitutive medium, similar to language.

> "In this view, language ... is no longer merely reflective but rather a constitutive medium. We create and give meaning to the world we live in and share with others .... To put the point in a more radical form, we design ourselves (and the social and technological networks in which our lives have meaning) in language." (78)

To the understanding of designers in the branches of product design and visual (graphics) design this intertwining of language and design might seem unusual, since their comeptence lies in handling non-discursive codes, mainly drawings (and not in discursive codes). But that is not the point, insofar language is not a code for a supposedly "objective" reality, but a way of engaging in commitments. The theory of language as a theory of commitments is based on the works of John Searle who developed a speech act theory centered on commitments, i.e. the disposition of the speaker to engage in actions that lead to fulfill certain conditions of satisfaction. He distinguishes between two types of matchings:

**world-to-word match** and **word-to-world match**. When we design, we are moving in the domain of world-to-word match, i.e. our **designs are commitments to modify the world in such a way as to match it to our intentions.**

Another central concept in the design theory of Winograd and Flores is "breakdown". A breakdown is a necessary concomitant of any design, not because of the lack of competence of the designer, but because of the nature of the design process.

> "A breakdown is not a negative situation to be avoided, but a situation of non-obviousness, in which the recognition that something is missing leads to unconcealing... some aspect of the network of tools we are engaged in using. A breakdown reveals the nexus of relations necessary for us to accomplish our task. This creates a clear objective for design - to anticipate the forms of breakdowns and provide a space of possibilities for action when they occur." (165)

The term "breakdown" is taken from Heidegger (Bruch, i.e., interruption of the flow of obviousness) and is not to be taken as a concept with negative connotations. The act of designing is linked with the intrinsic possibility of breakdown. A good designer is more than an expert in imagining tools that work, (physical artifacts, communication artifacts, organizational networks), i.e., an expert in imagining situation in which these tools might not work - and providing efficient alternatives for action in case of breakdown.

For constructing the fundamentals of design, the authors refer to various scientific and philosophical universes of discourse:

- the philosophy of thrownness as a condition of being-in-the-world (Heideger);
- Humberto Maturana's insight that meaning and "world" only grow out of and are constituted by the concernful activities of the person; furthermore to Maturana's studies of perception based on research on colour perception of the frog's eye which are directed against the so-called mapping theory according to which a colourful world is mapped onto the nervous system; he emphasizes the participation of the nervous system in the generation of the colour space of the observer.
  The authors agree with Maturana attacking the representation theory of reality in computer sciences, language, perception, learning and education;
- the contributions of hermeneutics with the emphasis on the role of context for understanding (Gadamer);
- the speech act theory of Austin and Searle: language understood less as a sign system for representing reality, than as a tool to engage in commitments;
- a critical evaluation of the proclaimed aims of research in artificial intelligence, and the role of computers.

One important conclusion the authors draw is the ontological difference between computers as symbol handling devices and human language: computers may be - and in fact are - powerful tools in communication based on language, but they are excluded from engaging in commitments, i.e., they are excluded from the essential use of language.

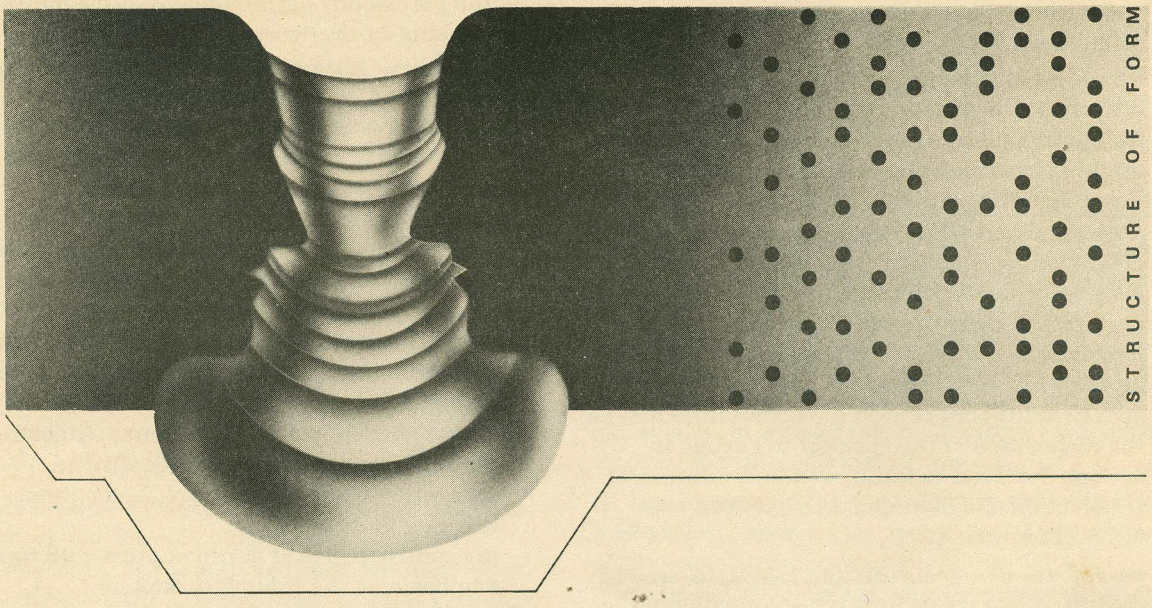
This critique permits evaluating the ambitious aims of the Japanese government sponsored programme for the creation of 5th generation computers, and to show that the unspoken theoretical assumptions on which the major part of research work in computersied translation, and artificial intelligence is based, are untenable.

For designers of whatever specialization this book reveals itself as a source for stimulating thoughts about the question: What we are doing when we are designing? The constitutive blindness of design practice might become reduced by this new seminal foundation for design. ■

# STRUCTURE OF FORM

## A SERIES BASED ON PERCEPTION & INFORMATION PROCESSING

**U.A. Athavankar**




**Part 3**

**Abstract:**

**In this article, the focus is shifted on learning of form/message. Concrete evidence is presented on how and why structure facilitates learning of form.**

**The article investigates the role of spatial structure in learning, using information theory framework. A model is proposed, exploring the nature of relationship between visual information and structure. The model presents alternative formal strategies available in designing.**

**The article argues that the new framework not only broadens the concept of structure, but allows designer's intuitive handling of subtle forms of spatial relationships to be interpreted as a logical & conscious process of controlling the visual information.**

In spite of our limited capacity to handle information, we continue to learn about objects and events in the environment only because, we appear to have evolved a very efficient way of dealing with incoming input information. Think of how we identify a given musical composition, even when played on different instruments, at different volumes & at different octave levels or for that matter, when it is hummed by different people! The efficiency with which we can deal with such variations indicates that the perceptual system must be striving to attain a more universal description of the input, that permits such variations to be identified. Perhaps such a strategy pays equally in replaying musical composition. It is again this description that is recalled and interpreted to suit the musical reproduction instrument.

We deal with visual information in similar way. The visual pattern recognition as well as recall requires that observers develop an internal representation of the input, which is universal and yet sufficiently rich to deal with reasonable transformations caused by viewing angle, viewing distance and light level as well as limited alterations in size, brightness & colour. Sutherland indicates that people store patterns in terms of abstract descriptions. He argues that

input features (feature list) must be complemented by coding of structural relationships between parts of the pattern.[21]

It appears that our learning process is based on coding of the invariant structural relationships between the elements. Its this special attention to relationships that gives universality to the encoded description. In fact number of words in our language directly refer to such invariant relationships. For instance, triangle, square refer exclusively to relationship of parts without reference to colour, size & medium of reproduction.

Attention to relationships or the structure of the shape, not only increases information transfer as seen earlier, but it is an inevitable part of our information processing. What role do the structural relationships play in the learning process, when we encounter a new input? Is the effectiveness in learning dependent on the nature of relationships? Can the learning process be predictably controlled? We can now begin to explore the possibility that was hinted in the earlier article - the possibility of controlling communication & information transfer.

**Learning of Form**

For the purpose of these series of articles, we will define learning as processing of input shape/message, that will lead to developing an abstract structural description of the pattern. Within this limited definition, it is possible to measure learning in identification and recall tasks.

It is reasonable to propose that our ability to understand and learn the form/message will depend on properties of the message as well as our abilities to perceive and use these properties. We will of course touch the differences, in the abilities of individuals to process the form. However the focus will be on the former aspect. As designers we are primarily concerned with the design of the form/message and its only right that we concentrate on the properties of the message, its structure & its influence on communication and learning.

One of the ways to understand the nature of form/message is to look at the learning difficulty that the observer encounters, an aspect that has not been paid the attention it deserves. Let us assume that learning difficulty is related to the mental efforts required to process the structure or relationships in the elements of the message. The hypothesis raises some interesting questions such as, are certain forms of relationships easier to process than others? If so, are certain forms considered simple because the relationships between the elements can be processed more easily and efficiently? Though the approach sounds logical, it has major limitations. It proposes 'structure' as the only variable that influences learning - a hypothesis that does not appeal to the commonsense. It is reasonable to assume that message is also easier to learn, if it has less information.

**Visual Information as a Concept:**

To answer these questions the approach must be broadened to include quantification of input information and correlating it with learning accuracy - the direction essentially requires that we suggest means by which we can define and quantify the information in a shape/message.

Initially, the discussions that follow may appear as diverting from the general theme of structure and its effect on information processing. But as we will see later, information and structure are closely related concepts and infact it is difficult to discuss them, without refering to each other. Considering the tremendous influence information theory had on research in visual perception, broadening the scope is definitely worthwhile.

The concept of visual information is not new to the design field. Designers when discussing a form, do make occasional references to information levels, perhaps using more conventional words like simplicity and complexity of forms. Designers also tend to control the visual complexity, to meet the demands of function and style . Yet, 'complexity' is defined as the status of an important formal property, that can be studied & dealt systematically.

It is not planned to extensively discuss how information in a shape can be measured. In fact its extension to real world forms is likely to be futile. As designers we are not really interested in the absolute values of information in forms. Our goal in this article is to mainly understand the basis of information in visual patterns, the relationship between information and structure and its effect on learning. Later we will explore the alternative strategies of controlling information and structure, hoping that it will complement the current intuitive design approach. We will return to these topics after a brief introduction to information theory as it was interpreted and used in pattern perception research.

**Measuring Visual Information**

Psychologists studying pattern perception have infact shown greater concern for relating information concepts to visual inputs than designers, and have gone about studying them objectively. They viewed with great interest the development of information theory. The ability of information theory to deal with somewhat abstract ideas such as 'organization' and 'structure' in a quantitative manner, was particularly appealing to psychology but is equally useful to designers. In this new view, the 'amount of information' was recognized as an energic property of patterns, allowing the patterns to be scaled and ordered along the information continuum.

Shannon's two part paper on theory of communication was a radical shift from the commonsense understanding of the concept 'information'. He related information measurements to the existence of uncertainty about the outcome of an event, prior to that event. Amount of information is solely determined by the amount of uncertainty. Garner explains it elegantly.

.... Uncertainty is potential information and the measurement of amount of information is the same as measurement of the amount of uncertainty.[22]

Bit is used as a measure of information. When there is uncertainty due to two equally probable alternative outcomes, the decision carries one bit of information. Using uncertainty as a basis of measurement could be extended to visual patterns, only by accepting certain restrictions on the development of patterns. Patterns were developed using matrix specially where each cell had two (or more) states - it can be filled with a dot or it can be blank. Each cell as a variable with two equally probable alternatives, carried one bit of information. So a typical pattern with 4 × 3 matrix carries 12 bits of information.

The information pattern could be controlled by using two possibilities. Size of the matrix can be altered, which will correspondingly change the amount of information in the pattern. Further, the information can be controlled by use of constraint or rule that influenced the possibility of cell retaining a dot. Figure 12 gives some example of patterns & their variations.

Constraints or rules specify the nature of relationship between the filled cells and in the process create redundancy. Typical constraint such as mirroring is expected to add redundant information. The terms constraint or rule, used in spatial context, control the spatial relationships between the cells.[23] So in spite of the new terminology used, the structure remains the focus of our discussions.

Patterns generated thus were used in learning experiments, where the subjects were given initial presentations of set of patterns & were later asked to identify or reproduce them. This system of pattern generation allowed responses to varied kinds of patterns to be compared. For instance, in figure 12 lateral comparisons would show the effect of amount of information, while vertical comparisons show the effect of structure on learning. It is significant that information theory framework allowed even diagonal comparisons, where effects of simultaneous changes in both the variables could be studied. It is this possibility that revealed the nature of relationship between the two variables.

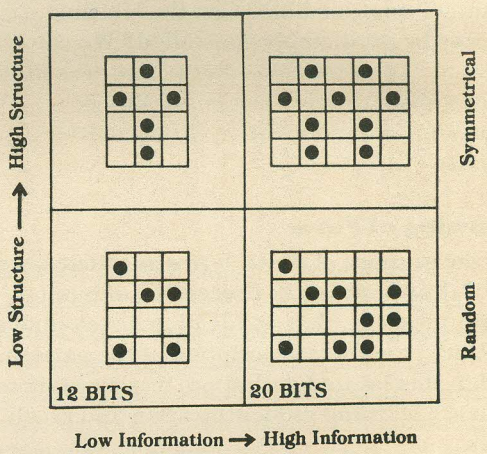



**Figure 12**

**System of generating visual patterns by varying number of cells (or matrix size) and nature of constraint that influenced the probability of cell carrying a dot.**

We plan to briefly present a series of experiments in pattern learning, that explore the nature of relationship between the two variables - information and structure. As we will see later, the strategies to deal with visual information emerge out of this relationship. These discussions will also help us more accurately define concepts like visual information & visual structure and establish their role in communication and learning.

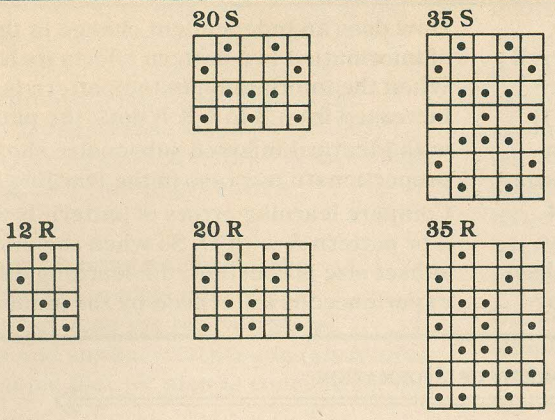



**Figure 13.1**
Attneave used five classes of patterns. 12R patterns use 3 × 4 matrix with random dot arrangement. 20R patterns use 5 × 4 matrix and contain 12R at the left corner with random addition of dots. 35R patterns use 5 × 7 matrix and contains 20R at the top with random addition of dots.

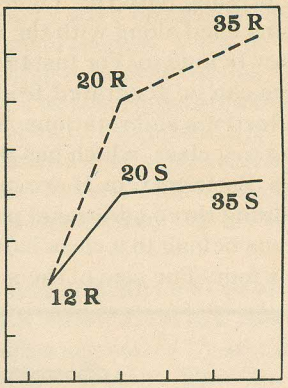



**Figure 13.2**
These patterns represent increase in the amount of information from 12, 20 & 35 bits. Patterns 20S & 35S are generated by reflecting 12R & 20S. The additions due to reflections are redundant. 13.2 shows accuracy of reproduction for all five classes of patterns.

## Role of Spatial Events

Contributions of spatial events in pattern information were first explored by Fred Attneave.[24] In his pioneering experiments he investigated the role of information and redundancy created by structure of the pattern, on memory of patterns. These experiments no doubt deal with somewhat more obvious forms of spatial relationships such as symmetry. However we will also refer to other experiments later, which explore the effect of more subtler forms of relationships.

Attneave in his pattern learning experiment used five classes of patterns. The typical patterns that belong to each of the class along with their computed information value are shown in figure 13.1. His subjects went through a paired associate learning task, where they learnt to associate a particular alphabet with each pattern presented to them, during the learning sessions. The presentation ensured that subjects had adequate time to encode the pattern and associate it with the alphabet. The subjects were asked to reproduce the patterns later.

Figure 13.2 shows the accuracy of reproduction for various classes of patterns. A careful look at the results show insight into the role of spatial constraints or structure of patterns.

Comparison of reproduction errors of patterns 12R, 20R and 35R shows that the increase in matrix size and the amount of information is logically reflected in the increased learning difficulty. On the other hand, when the number of matrix cells are constant, constraint such as symmetry has an advantage in learning. For instance compare errors for patterns 20R with 20S, and 35R with 35S. In pattern learning, structure such as symmetry, seems to substantially compensate for the increase in the number of dots or cells.

Attneave proposed that since patterns 20S and 35S are reflections of 12R, the increase in the number of cells is totally redundant. So all the three classes of patterns theoretically carry only 12 bits of information. Yet 20S and 35S show increase in reproduction errors than 12R. . Attneave concedes that simplicity (amount of information) and symmetry (structure) seem to contribute independently and should be treated as two factors that in this particular case oppose one another. It appears that the perceptual mechanism is capable of encoding constrained patterns into simpler and more compact form, though it operates in a manner far from ideal.

Structure or constraints can only partially compensate for increase in number of cells and the consequent increase in the amount of information. Pattern information and structure can be treated as two factors, that influence learning. But do they independently influence learning? This is the topic that we will turn to.

Garner[25] has reported similar results. However his information measurements use a slightly different framework. So we will limit our comparison only to the portions that account for effect of differences in spatial relationships in the elements, on learning of patterns.

These experiments explore the role of structure[26] by treating a single pattern as a member of a set of patterns that can be inferred from it. This new concept needs a brief explanation. Inferred set is generated by reflections as well as 90° and 180° rotations

of the original pattern?[27] Figure 14 shows the patterns used along with the size of the inferred set they belong to. For instance only one more pattern can be generated from pattern A or B by reflections and rotations. So these pattern belong to a class, which has inferred subset size as two. Patterns C or H are members of a set containing three additional patterns. So these patterns belong to a class having inferred subset size as four. The size of the subset that can be

How does an independent change in the amount of information in a pattern affects its learning? When the information in the pattern is increased from 3 to 4 & 5 dots, the patterns with identical inferred subset size show a proportionate increase in the learning difficulty. Compare learning errors of pattern B with C and J or pattern A with D. So when the inferred subset size is constant, the learning difficulty experienced is influenced by the amount of

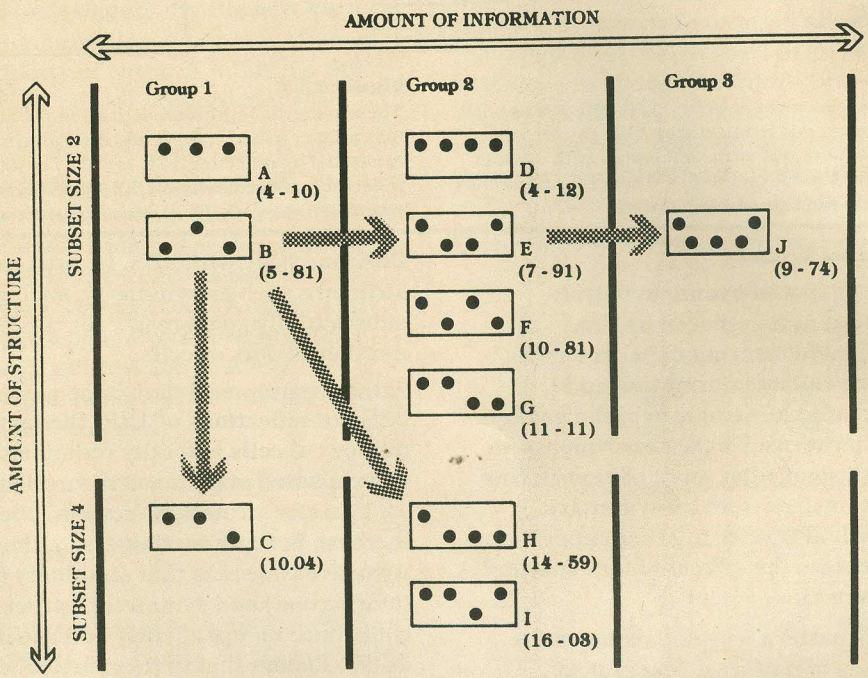



**Figure 14**

Indicates mean errors in learning each group of patterns (shown as values in brackets). The change across both the variables is reflected in almost a triple increase in the mean error. Compare B with H. This increase looks particularly glaring, when compared to errors due to changes along a single variable.

theoretically generated from a pattern is a critical factor since it measures the amount of symmetry or structure in a pattern. It is proposed that the learning of pattern is influenced by the size of the inferred set.

The patterns were generated using 3,4 and 5 dots, where dot was treated as a binary variable i.e. the dot could be at one of the two places along the vertical column. Learning difficulty is measured by computing the mean error in identification of class of patterns, after a paired associate learning task. Mean errors are shown in the figure 14 along with the patterns used.

The design of the experiment treats amount of information (number of dots) and size of the inferred set structure as two variables. To understand the exact role played by these variables, the initial comparison of results have to be restricted to changes along a single variable.

information in the pattern. Comparison of errors of pattern C with H and I, also supports this conclusion further.

The results show that the size of the inferred set is also a critical factor. When the number of dots or amount of information in a group of patterns is constant, the learning difficulty is some function of the size of the set inferred from it. Three dot patterns A & B with a subset size of two, show less errors than pattern C, which is a member of a subset having four patterns. The errors in more complex four dot patterns confirm this view further. For instance learning errors for pattern D,E,F & G are smaller than for H & I, which belong to a larger subset size.

How is learning of patterns affected by changes along both the variables? Compare three dot pattern B belonging to a subset size of two, with four dot patterns H and I.

The later patterns have more information and also they belong to inferred subset size of four. The change across both the variables is reflected in almost a triple increase in the mean error. This increase looks particularly glaring, when compared to errors due to a single variable. Figure 14 attempts such a comparison.

Using pattern learning as a basic, the experiment infact reveals interesting relationship between the two variables: information and spatial relationship (structure). This is the topic that we plan to concentrate on.

**Nature of Relationship between Information and Structure.**

It is important to review the results before we proceed further. Both the experiments cited earlier deal with learning of patterns. Differences in theoretical positions, experimental procedures & tasks make direct comparison impossible, except in a limited way, where pattern learning and structure are treated as central issues.

Attneave's results support the hypothesis that learning of pattern is related to the amount of information it carries. Attneave treated information as a spatial concept and spatial events such as symmetry were directly included in his information measurements. While he established that learning is dependent on amount of information, he also suggested that learning results can be better explained, if amount of information and spatial structure are treated as independent factors. This is precisely what the experiments reported by Garner try to attempt.

Garner projects learning difficulty as a result of simultaneous effects of information in a pattern and spatial relationships accounted by size of the inferred subset of that pattern. Since he uses a different theoretical framework for information measurements, the results must be reinterpreted for comparison.

These experiments show a finer understanding of nature of spatial relationships, by proposing the concept of inferred subset size. If information in a pattern is treated as spatial concept as we have done so far, the concept of inferred subset size based on spatial events can be treated as a measure of amount of spatial structure in a pattern. The results, consistent with Attneave's results, clearly show the relationship between learning of pattern and the

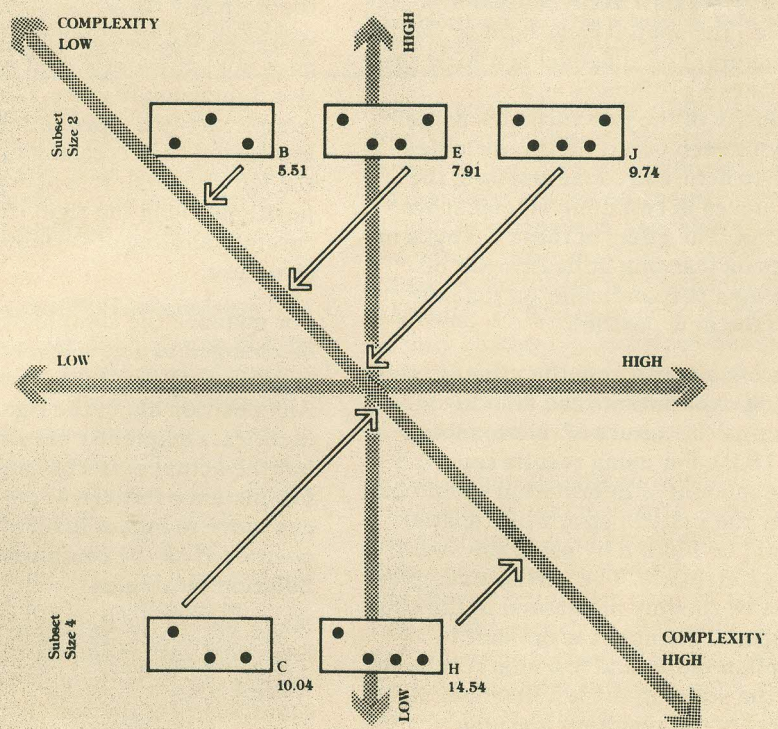



**Figure 13**

The diagram shows complexity as a cumulative result of relationship between the two variables - information and structure. Attempt is made to position the patterns from the previous experiments, along the two variables.

spatial structure. For example, the patterns belonging to smaller subsets such as patterns A & B, are typically symmetrical. They are more structured and are also easier to learn. Patterns belonging to larger inferred subset size have low spatial structure and show greater learning errors. Patterns such as C, H & I fall into this category.

The fact that some spatial relationships are more effectively used in learning than others, suggests that the communication process can be explained better if 'structure' is treated as a variable, than can be measurably controlled. These experiments support this possibility by proposing an objective process such as inferred subset size for measuring structure in a pattern.

The possibility that, like amount of information, the structure can be also treated as a variable that can be controlled is important to design field. Representing information & structure as two variables in two dimensional space, figure 15.2 attempts to graphically conceptualize their relationship, based on the clues offered by the results of the experiments cited earlier. Such a generalized model is more compatible with the requirements of design tasks, even though it may not be very accurate.

The variable, amount of information is plotted along axis X, while axis Y represents the second variable - the spatial constraint or the amount of structure. Left diagonal is a scale that indicates the learning difficulty as a cummulative effect of the two variables & their relationship with each other. As the variables information & structure are manipulated, the pattern/form moves in two dimensional space, to a new position. The effect of these changes in variable values on learning difficulty, can be seen by dropping a perpendicular on the left diagonal, from the new position.

The examples of patterns from the already cited pattern learning experiments can help in further explaining the nature of relationship. (Refer figure 15.2). For using results reported by Garner, the amount of information should be represented by the mattrix size, while spatial structure should be plotted by using the size of inferred set as a measure. The earlier examples of patterns can be roughly positioned in the two dimensional space. Though it is difficult to accurately explain individual learning results of each pattern, the scale on the left diagonal does give a quick feel of the resultant learning difficult due to spatial changes. It is reasonable to assume that learning difficulty reflects observer's holistic judgement of the complexity of the patterns and we plan to refer to it as a scale that represents visual complexity.

The representation in two dimensional space not only shows the effect of changes along a single variable on learning difficulty, but also it effectively brings out the combined effect of two variables. It clearly shows that increase in number of elements and simultaneous decrease in spatial structure will rapid shift the pattern downwards along the diagonal as in case of patterns B and H. Reverse process will shift the pattern diagonally upward. However the model brings out something very startling - **that it is possible to make substantial changes in the form without changing its position on the diagonal.** For instance any movement along the right diagonal has no effect, or only a marginal effect on its position on the left diagonal. It is the interesting compensatory effect of variables on each other that make this possible. Increase in number of elements with a simultaneous increase in spatial structure tends to compensate for each other as in patterns C and J.

What is the significance of this peculiar relationship of the two variables, to the design field?

The model also throw some light on the nature of two important spatial concepts: Visual simplicity and visual complexity. If learning of form is seen as a central issue, then theoretically these concepts can be treated as two ends of a continuum. But such a picture does not sufficiently deal with the realities of two dimensional space. Controlling of the visual complexity is not just a unidimensional increasing or decreasing of the complexity along the left diagonal. It is also a clever use of positions along the right diagonal that requires careful handling of variables like information & structure.

For instance the complexity of the patterns can be changed to a new level and yet there is considerable flexibility in achieving this goal. Any position along the right diagonal shows identical complexity of information processing, but the actual patterns can differ considerably. For instance Pattern at position A in Figure 16 can move to higher level of complexity, say position B on the complexity scale, using different strategies.

Major part of the design actions in synthesis of form deal with manipulation of the visual complexity. It is the understanding of the relationship of the variables, that permits generation of alternative strategies to control visual complexity. The model can offer the conceptual background for such a task.

Though freedom to exploit the two dimensional space exists, in reality the choice of the position

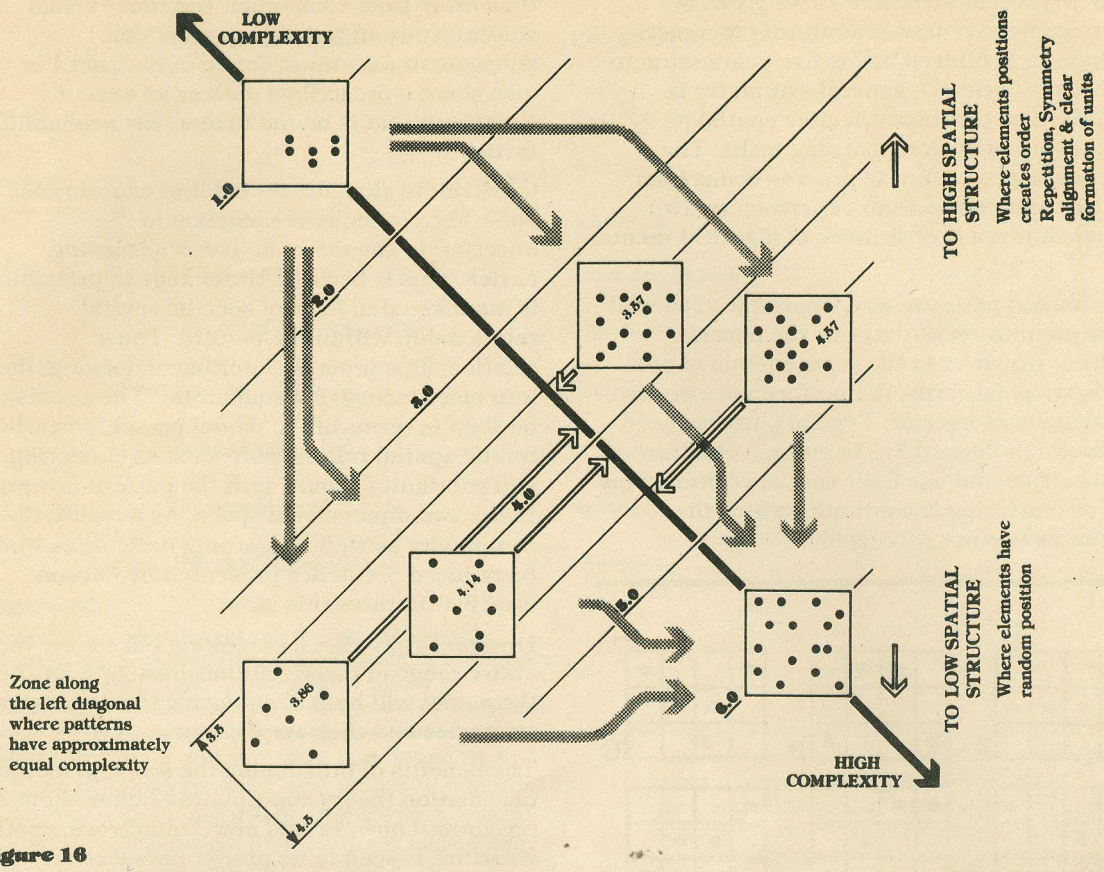



**Figure 16**

Pattern movements in two dimensional space. Pattern at position A can move to complexity level B using different strategies. The patterns along the right diagonal at B, share approximately equal complexity of information processing. The selection of patterns is based on subjective judgement and is mainly for demonstration purposes.

and strategy is influenced by the designer's philosophical commitments and inclinations. Perhaps a careful scrutiny of the space might suggest how various design movements have exploited a distinctive position in the space. More about it later.

## Role of Subtler Spatial Relationships

The model showing the influence of variables is not intended to be used as a device to compute learning difficulty. To develop a computational device based on results of two experiments is inconceivable, particularly when the examples discussed mainly use obvious constraints such as symmetry. While symmetry is no doubt important and probably the most effective constraint from the point of view of learning, our perceptual mechanism is also equipped to process subtler forms of spatial relationships. The concept of inferred set proposed earlier is not sufficiently sensitive to account for subtler but perceivable changes in the spatial relationships, that we can use in learning tasks.

The model mainly explains the nature of relationships of the two variables and their likely effect on learning of patterns. Since exact computation of learning difficulty is not our goal, the variables could be made more inclusive, based on available data. For instance the variable 'spatial structure' could include subtler relationships, provided they contribute to learning process. What is the degree of influence that these relationships have on learning? To find answer to this we have to slightly change our approach and perhaps ask 'Can the difficulties experienced in pattern learning tasks help in ordering the various forms of spatial relationships?'

Gibson[28] has attempted this in her review of experiments that deal with various pattern learning tasks, given to subjects of different age groups and I.Q. Most of these experiments test the Gestalt principles dealing with spatial relationships such as similarity, proximity, good continuation, repetition and symmetry. Though no accurate order is established, rough indicators do emerge. Beside, these experiments point to a finer understanding of the concept of structure, from the communication point of view.

In general the review points out clearly that we

'learn' to process structure as we grow. For example effectiveness of similarity increases with age and children below five years seem to neglect similarity. In general symmetry is recognized as the most effective spatial relationship in pattern learning tasks. The evidence that we learn to process & use finer relationships comes from experiments with normal children & retardates of identical mental age.

Symmetrical patterns were reproduced as well by the mentally retardates as the normal children. However in the reproduction of non-symmetrical patterns, the performance of the retardates was inferior. Typical patterns used are shown in figure 17. The normal children could extract and use finer spatial relationships such as clustering & continuity which the retardates had not perceived.

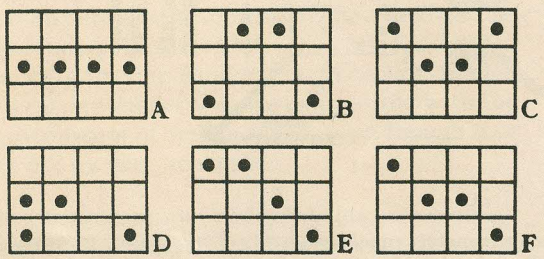



**Figure 17**

In reproduction of non-symmetrical pattern such as D, E & F the performance of the retardate children is inferior. They are not able to take advantage of subtle spatial relationships such as clustering as in pattern D & partial continuity as in pattern E.

It appears that our ability to perceive order or subtler spatial relationships varies with age & intelligence. Symmetry appears to be more effective than repetition. However, with greater intelligence, it is possible to use subtler forms such as distinctive clusters and continuity of line.

### Understanding Spatial Structure

On the face of it, clustering, and continuity appear as isolated spatial events, and one fails to see their role in the concept of structure as well as learning. In fact it is difficult to see patterns having clustering or visual continuity as constrained patterns. To understand this, these patterns must be compared with other patterns, where the dots are randomly distributed in the entire field. Clustering can form only if the constraint increases the probability of the dots occuring near each other, than away from each other. Similarly visual continuity or alignment requires that subsequent dots must not be only closer but also share a prescribed path or an axis, a constraint that is bound to alter the probability further.

Constraints alter the probability of occurance of dots. The consequent reduction in the uncertainty should make pattern learning easier. This is because the change in probability is manifested in form of specific spatial relationship within the pattern. These relationships prompt chunking of dots together into more inclusive visual units[29]. The events can be seen in terms of the model presented earlier. Subtle spatial relationship such as clustering and continuity should shift the pattern upward in the two dimensional space. As a result, the complexity as well as learning difficulties would be reduced. Evidence presented by Gibson clearly reiterates this point.

Designers have been exploiting effectively the entire range of these relationships, and for them the model will help in exploring the alternative strategies and their implication.

The benefits of broadening the scope to include information theory concepts can be immediately recognized now. In this new framework, spatial structure is seen in its proper perspective, where it justifiably includes the entire range of spatial relationships. The results of the learning experiments cited earlier support this contention further. Typical examples from the range of spatial relationships are shown in figure 18.

All the evidence presented so far suggests that the use of the term spatial structure need not only indicate obvious forms such as symmetry, but must be broad enough to also include subtle forms of spatial relationships.

### Coherence of Form

Spatial structure of the form is based on sharing of spatial relationships by the elements. Since given number of elements can share more than one form of spatial relationship, it is important to see spatial structure as a scalable and controllable concept. When elements share multiple spatial relationships, they emerge as a single coherent visual unit.

As designers, we are quite obssessed with relationships, particularly subtler spatial relationships. Relationship is the basis of coherence and no designer wants to make a visual statement that is not coherent.

Perhaps as designers we can pause for a moment and look at the spatial decisions that we have been taking in the past, such as .....

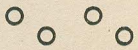
| Spatial Relations | Effect | |
|---|---|---|
| | Similar Elements share | |
| Is closer to | Proximity |  |
| Is aligned with | Alignment |  |
| Is in line with | Continuity of Path |  |
| Is at equal distances with | Distance unit |  |
| Is along the axis of | Common axis |  |
| Is mirror image of | Symmetry |  |
| Is a repetition of | repetition |  |
| Follow an orientation of | Orientation |  |

**Figure 18**

**Since number of spatial relationship shared by given elements can be controlled, structure should be treated as a scalable concept. Figure shows range of spatial relationships used independently or together by designers.**

where to start a line or a title in a layout or a grill on the product face? and where to end it? Haven't we been always searching for a way to show the relationship by aligning it with some other visual element?

When such spatial relationships are naturally not possible, they are ensured through external devices. The ideas such as use of grids, modules and repetitive use of specific sizes are efforts to ensure a framework in which decisions will automatically share distances, sizes & alignments.

Structure is a minimum condition for coherence, but is coherence only a spatial phenomenon? If we are discussing communication & learning can we afford to neglect the role that size, colour or texture play? Can we afford to exclude these attributes from our concept of visual structure & complexity? The idea of structure will not be complete unless it includes these aspects. This is the topic that we plan to discuss in the next article.

## REFERENCES


21. Sutherland N.S., Object Recognition. In Handbook of Perception, Vol 3, ed. E.C. Carterettc & M.P. Friedman, Academic Press, 1973, pp 157, 185.

22. Garner, W.R. Uncertainty and Structure as Psychological Concepts, John Wiley and Sons., New York, 1962, p-7.

23. Because of the differences in information measurement procedures, it is important to state the position adopted in these articles. Since designers are mainly concerned with spatial phenomena, information is treated as a spatial concept and is expected to vary with spatial change. Similarly the term constraint and structure refer to spatial events only.

24. Attneave F., Symmetry, Information and Memory for Patterns, American Journal of Psychology, 1955, 68, 209-222.

25. Garner W.R. The Processing of Information and Structure, Lawrence Erlbaum Associates, 1974, pp 41-51.

26. Garner has treated the effects of spatial relationships on learning of patterns, as effects of a particular form of redundancy. With the result, the nature of spatial relationship does not influence computed information. Though the scheme fully acknowledges their influence on learning of patterns, technically the term structure can not be used in his scheme to refer to spatial constraints. The results are reinterpreted from the position mentioned in 23 above.

27. Garner W.R. Ibid., pp 13-15.

28. Gibson E. Principles of Perceptual Learning & Development, Appleton-Century-Crofts, 1969, pp 466-469.

29. This aspect is extensively discussed in part 2 of this series in Abhikalpa, July-Dec. 84, pp 22-35.

# स्थपतिलक्षणम्

**Characteristcs of 'Sthapati' (architect - designer)**

'Samarangana Sutradhara' is an encyclopaedic work on medieval Indian architecture written by King Bhoja of Dhar (c. 1000-1055 A.D.) of the Paramara dynasty. Bhoja was a great partron of learning and himself a distinguished architect, poet, aesthetician and author. We reproduce below verses from Chapter 44 of this work, which describes characteristics and qualities of a 'sthapati (architect). It is interesting how the text does not consider knowledge of theoretical sciences and proficiency in practical aspects sufficient for the architect. In addition he must be endowed with intellect, character and integrity, without which his actions will not bear fruit.

स्थापत्यमुच्यते ऽस्माभिरिदानीं प्रक्रमागतम्।
ज्ञातेन येन ज्ञायन्ते स्थपतीनां गुणागुणाः ॥१॥

The science of 'architecture/engineering' is being explained by us now, as it has come down in the tradition. By knowing it, the qualifications and disqualifications of an architect-engineer are understood. (1)

शास्त्रं कर्म तथा प्रज्ञा शीलं च क्रिययान्वितम्।
लक्ष्यलक्षणयुक्तार्थशास्त्रनिष्ठो नरो भवेत् ॥२॥

The person (architect) should be well-versed in the science incorporating the import of objects to be defined and their definitions. He should know the theory and the practice; he should have the insight and the skill accompanied with procedure. (2)

सामुद्रं गणितं चैव ज्योतिषं छन्द एव च।
सिराज्ञानं तथा शिल्पं यन्त्रकर्मविधिस्तथा ॥३॥

एतान्यङ्गानि जानीयाद् वास्तुशास्त्रस्य बुद्धिमान्।
शास्त्रानुसारेणाभ्युद्य लक्षणानि च लक्षयेत् ॥४॥

A wise one should know that palmistry, mathematics, astronomy, vedic lore, anatomy, artisanship and mechanics are the component parts of the science of civil engineering. He should locate the characteristics according to shastric injunctions. (3, 4)

प्रसिद्धशास्त्रदृष्टान्तैर्वास्तुज्ञानं प्रसाधयेत्।
वास्तुनः ससिरावंशैर्मर्मवेधैः सुनिश्चितैः ॥५॥

वास्तुद्वारक्षणान् भूयः सर्वान् जानाति शास्त्रतः।
यस्तु शास्त्रमविज्ञाय प्रयोक्ता स्थपतिर्भवेत् ॥६॥

One should accomplish the knowledge of a site based on the analogy of the established shastric conventions. The architect understands all the facets of the site by grasping the veins, nerves and the vital parts and joints of the person in the form of site (Vastu) after proper ascertainment. (5, 6)

हन्तव्यः स स्वयं राज्ञा मृत्युवद् राजहिंसकः।
मिथ्याज्ञानादहङ्कारी शास्त्रे चैवाकृतश्रमः ॥७॥

अकालमृत्युर्लोकस्य विचरेद् वसुधातले।
यस्तु केवलशास्त्रज्ञः कर्मस्वपरिनिष्ठितः ॥८॥

He, who begins to work as an architect without knowing the science (theory) of architecture, must be put to death by the King as one who ruins the Kingdom. Otherwise proud with false knowledge, and without taking any pains to understand the theory, he would move on the surface of the earth as 'untimely death' of the people. (6, 7, 8)

स मुह्यति क्रियाकाले दृष्ट्वा भीरुरिवाहवम् |
केवलं कर्म यो वेत्ति शास्त्रार्थं नाधिगच्छति ||९||

सोऽचक्षुरिव नीयेत विवशोऽन्येन वर्त्मसु |
कर्म वास्तुविधेः स्थानं मानमुन्मानमेव च ||१०||

One who is however well-versed in theory alone, but is not trained in practice, will faint at the time of action like a coward on the battlefield. Similarly one who is expert only in his workmanship, but does not know the theoretical aspects, will like a blind man be misled by anyone. (9, 10)

क्षेत्रजानि च कर्माणि लुमालेरवार्ध्य तुर्दश |
चत्वारो गण्डिकाच्छेदान् वृत्तच्छेदेषु सप्तसु ||११||

सुश्लिष्टं सन्धिसन्धानैरधरोत्तरसंयुतम् |
बाह्यरेरवान्वितं शुद्धं यो जानाति स कर्मवित् ||१२||

That person is said to be an expert in workmanship who knows the location for sketching the ground plan, draftsmanship, the horizontal and vertical measurements, the details of ground work of the plot, the fourteen kinds of sketch lines (luma-lekha), the cutting of the logs and stones etc., and seven kinds of circular sections; well finished joinings of the joints and proper demarcation of upper, lower and outer lines. (11, 12)

शास्त्रकर्मसमर्थोऽपि स्थपतिः प्रज्ञया विना |
फलेयुः कर्मभिरन्याभिः स्यान्निर्मद इव द्विपः ||१३||

The architect who is capable of theory as well as practice would however be ineffective without intellect like an elephant of exhausted ichor; and his actions will not bear fruit. (13)

प्रत्युत्पन्नमतिर्यः स्याद् वाहकः स्थपतिस्तथा |
कर्मकाले न मुह्येत् स प्रज्ञानेनोपबृंहितः ||१४||

अप्रज्ञेयं दुरालोकं गूढार्थं बहुविस्तरम् |
प्रज्ञापोतं समारुह्य प्राज्ञो वास्तुनिरं तरेत् ||१५||

The architect who is ready-witted would not get perplexed at the time of work, if he is endowed with intellect. A wise one would sail through the ocean of architectural undertaking even though it would be incomprehensible beyond perception, full of mysterious objects and vast in expanse, by boarding the boat of wisdom (prajna-pota). (14, 15)

ज्ञानवांश्च तथा वाग्मी कर्मस्वपि च निष्ठितः |
एवं युक्तोऽपि न श्रेयान् यदि शीलविवर्जितः ||१६||

रोषाद् द्वेषात् तथा लोभान्मोहाद् रागात् तथैव च |
अन्यचित्त्यत्वमायाति दुःशीलानामविक्षयात् ||१७||

However one who is knowledgeable, endowed with speech and loyal to one's duties is still not preferable, even though equipped with all these, if he is lacking in character. Such a one is liable to detraction of mind due to anger, hatred, avarice, infatuation or passion; since his bad character persists. (16, 17)

शीलाधाने परं यत्नमाधितिष्ठेत् स्थपतिः सदा |
ततः कर्माणि सिध्यन्ति जनयन्ति शुभानि च ||१९||

शीलवान् पूजितो लोके शीलवान् साधुसम्मतः |
शीलवान् सर्वकर्मार्हः शीलवान् प्रियदर्शनः ||१८||

The person possessing character and integrity is worshipped in the world, is honoured by the virtuous, is readily welcomed and is eligible for all professional work. An architect should always endeavour to imbibe character in himself. Consequently, his undertakings succeed and produce auspicious results. (18, 19)

तथाचाष्टविधं कर्म ज्ञेयं स्थपतिना सदा |
आलेख्यं लेख्यजातं च दारुकर्म चयस्तथा ||२०||

पाषाणसिद्धहेम्नां च शिल्पं कर्म तथैव च |
एभिर्गुणैः समायुक्तः स्थपतिर्याति पूज्यताम् ||२१||

स्थापत्यमङ्गैरिदमष्टाभिर्यश्चतुर्विधं वेत्ति विशुद्धबुद्धिः |
स शिल्पिना संसदि लब्धपूजः परां प्रतिष्ठां लभते चिरायुः ||२२||

An architect-engineer should know eight-fold workmanship, the draftsmanship and sketches of various kinds, and variety of carpentry, stone-masonary and gold-smithy. The engineer equipped with these merits invokes respect. One who knows the fourfold engineering with its eight constituents and who is pure in his mind gets status in the assembly of engineers and is endowed with long-life. (20, 21, 22)

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# Abhikalpa

**Abhikalpa = Design**
**(From Sanskrit 'Abhi' = towards, in the direction of;**
**and 'kalpa' = plan, proposal, prescribed rule or method)**