Design naturally, dealing with complexity of forms in nature & applying it in product design

Parsa Kamehkhosh, College of Fine Arts, University of Tehran, Bigworkin@hotmail.com

Alireza Ajdari, College of Fine Arts, University of Tehran, Iran

Yassaman khodadadeh, College of Fine Arts, University of Tehran, Iran

Abstract

The aesthetic NORMs have formed some presupposes in designers' **minds** which don't let their eyes see the reality of forms in NATURE before their abstracting mind see. They usually reduce complex forms to their basic geometries and proportions, in order to find orders in their complexity and to harmonize them with their design paradigms. We believe that this common vision to the nature, deprive us from perceiving its reality. This paper proposes a new vision to the nature and thereby present nature's approach to the form issue, and some of its manifestations. These findings which are presented under the title of DESIGN NATURALLY would guide designers, one step closer to the complex reality of forms in nature to get inspired by. Our point here is that this approach takes us far beyond the law-bound principles of the geometry and traditional design aesthetics and would create a new aesthetic language to the world of products based on the real complex world.

Keywords

Abstraction; growth story; forces; complexity; natural forms; design naturally.

Human's perception from the world is obedient to his mind (Nasr, 1996) and his mind is obedient to platonic forms and metric proportions (Alexander, 1964, Arnheim, 1979; Rotzler, 1977); these prevent us from seeing the complexity of world and understand it in the way it is (Rampell, 2003; warthall, 2005). Being obedient to these kinds of presupposes have had obvious effects on different aspects of human life and has manifested in the world of design in format of geometric forms and abstraction. Regarding to the changing meaning of the beauty and growing need for renewing the aesthetic language (Akner-koler, 2007), this study is aimed to propose a new vision to the forms in nature. This vision is based on ignoring the traditional aesthetic language and presupposes in order to create new theory of form and go beyond the law-bound principles of geometry.

Phenomenology is a compatible conceptual framework to explain the approach of this paper. Phenomenology is about studying phenomenon based on direct and pure experience and observance from the world and by ignoring presupposes (Verneaux &wahl, 2009). Just as phenomenology question presupposes to study the reality of things, we questioned the aesthetic norms and conventions in order to get closer to the reality of forms in nature.

Therefore, by taking a phenomenological approach, it is tried to break down presupposes and re-observe the forms in nature. This kind of visions opens designers' eyes to the ignored qualities such as complexity, irregularity, asymmetry, etc. These qualities could be applied as tools of renewing the aesthetic language and to find freedom from conventions in field of design (Bois & Krauss, 1997).

Quantitative approach

Rationalism and humanism of renaissance enabled a scientific revolution, which let scholars look at the world in a different light and by reason & knowledge. In the 16th and 17th centuries, in contrast with medieval centuries, knowledge was strongly based on rational calculus, mathematics and quantitative measurements (Bertelsen, 2004; Nasr, 1996).
Galileo, in his famous phrase under the title of "*IL Saggiatore"* likened the nature to a math book with geometric shapes as its letters. He believed that this book could be merely understood by human's rational mind (Nasr, 1996). Descartes' mathematical definitions of time, place and substance, has had the deepest affects on the essence of the modern science structures. His reductionism went to extreme until he defined nature as a physical moving reality which is merely understandable via geometry and quantitative measurements. Scientific revolution reached its zenith by Newton. He in his essay called *Principia* certainly declared the beginning of the quantitative and mathematical approach to the nature (Frangmyre *et al.*, 1990).

By the efforts of some individuals such as Christian Wolff[1], mathematical and quantitative methods were gradually developed in other fields of SCIENCE too (Frangmyre *et al.*, 1990). In fact scientists were strongly motivated to impose order on all domains of nature via quantizing and reducing its complexity. *L'esprit Geometrique* (geometric sprit) is the French expression for this extensive approach which were shadowing on all European scientific activities of 18th century and also affected many aspects of the western culture up to 20th century (Nasr, 1996).

Geometric Spirit

Industrial revolution in 19th century and modern technology stimulated the penetration of quantitative attitude to different layers of human life (Nasr, 1997), such as DESIGN. By the beginning of the 20th century, the approaches of the modern art movements such as cubism, purism, futurism and constructivism were to turn to SCIENCE for concepts and models (Akner-Koler, 2007; Heskett, 1993). These attitudes were based on the Influence of Idealist philosophical traditions, and the search for Platonic ideal forms. Therefore the quantitative approach of SCIENCE appeared toward abstraction and in particular, geometric forms in modern world of art and design (Heskett, 1993).
Art historian Alfred Barr categorized modern art into two main movements: *geometric abstract art* and *non-geometric abstract art*. This emphasis on geometric abstraction shows how a big role geometric abstraction played in modern art movements (Akner- koler, 2007).
Although post-modern criticized the modernistic approach to define universal principles, genotypes and the search for "pure form" (Rampell, 2003), the major manifestations of the post modernistic styles were again toward abstraction and geometric forms.

1 GERMAN PHILOSOPHER, (1679-1754)

Today, the aesthetic contributions of these movements have become the dominant aesthetic norms (Habermas, 1998) and they still dictate the conditions for beauty, at least for design and architecture (Akner-Koler, 2007).

The point here is that this tradition has also affected designers' visions to the FORMS IN NATURE. From a phenomenological point of view, it can be said that the aesthetic NORMs have formed some presupposes in designers' minds, which made them unable of seeing the reality of forms in nature before their abstracting mind perceive it. In fact, Designers usually reduce complex forms to their basic geometries and proportions, in order to find order in their complexity and to harmonize them with their design paradigms. The function of presupposes in human's mind is similar to the function of a red filter, which make a special wave length visible only (Gleick, 1988). In fact the filtering minds EXPECT to see geometric forms and patterns in nature and so reduce complex quality of forms to extract simple geometric patterns and proportions.

Deprivation from reality

Regarding to George Berkeley[2], the quantitative approach to the nature, abstracts its reality and presents the aspect, which is in our mind (Nasr, 1996).
Martin Heidegger explains that human usually escape from complexities and irregularities of universe. Reducing the infinite universe to understandable structures and models is equal with limiting it to our limited language also, taking this simplified model of reality as the reality itself, would surely deprive us from perceiving the reality of universe and would waste away its real values (Warthall, 2005).
In fact use of geometry entails a reductionism that excludes and "washes away" contact with the real world (Akner-Koler, 2007). Therefore, it can be concluded that abstracting natural forms in order to simplify their complexity, prevents us to perceive their reality. In other words geometric approach to the forms in nature deprive designers from seeing and perceiving many aesthetical values of natural forms.

Nature Inspired Forms

Deliberating forms in nature in order to receive inspiration from them is not a recent issue. The point is the way human represents his observations. We can categorize the human inspirations based on different degrees of abstraction. The more designers abstract natural form, the less the original properties such as asymmetry, irregularity, chaos and complexity would last. In this regard to 3 groups of Geometric, Geo-organic and Organic could be referred.

2 IRISH PHILOSOPHER, (1658-1753)

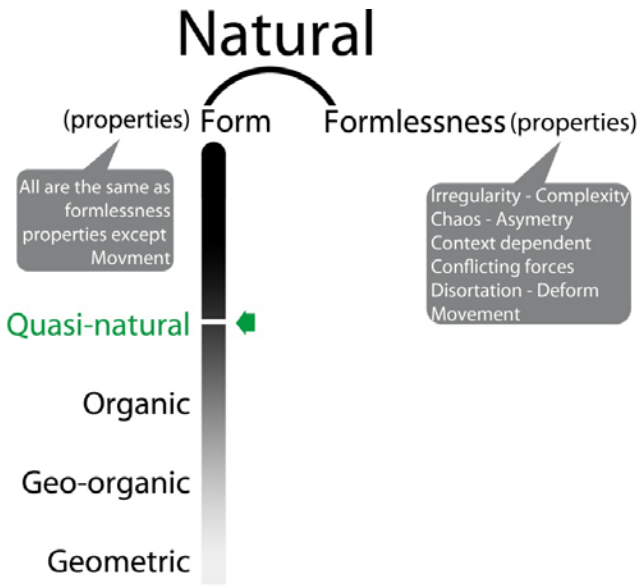

Figure 1 Different level of human inspirations from forms in nature regarding to the degrees of abstraction

Geometric

Golden section ratio and many of geometric patterns which are inspired by the nature are the result of geometric approach.

Geometric-organic Forms

This group refers to strong traditions in art and design, which merge geometric structural analysis with organic principles of growth and tension (Akner-Koler, 2007). By these traditions, Vladimir Tatlin and Mikhail Matiushin have been involved in studies of the efficiency and energy-conserving qualities of the anatomy of animals, which today might be called “bionic” approach (Tillberg, 2003). Many designers, engineers and biologists have endeavored in this field and have studied functional aspects integrated with morphological aspects of nature in order to receive inspiration (Trotto & Cianfanelli, 2006).

Bionic approach emphasizes on functional aspects and puts a great effort on harmonizing inspirations with design paradigms. Therefore, it always reduces natural forms to a general abstraction in format of products. Designers usually change natural forms in order to meet their design needs and so naturally they wash away many original qualities of natural forms in this process.

Organic Forms

As Waddington states:

> *"… We come then to conceive of organic form as something which is produced by the interaction of numerous forces which are balanced against one another in a near-equilibrium*

that has the character not of a precisely definable pattern but rather of a slightly fluid one, a rhythm..." (Wyte, 1968).

He also adds that: regarding the influence of man's intellectualizing, pattern-making habit of simplification, it is expectable that human's work of art would be a diluted version of the reality which has lost its unresolved complexity. Nevertheless, the problem starts when we equalize organic forms with natural forms; in fact we equalize a model or an aspect of reality with the reality itself which Heidegger showed that will deprive us from reality. It has become a kind of aesthetic norm that the result of studying natural forms to design things would be curved and smooth surfaces and circular shapes. But we have to consider that organic approach refers to just a level of abstracted natural forms with more attitudes to curves and fluid forms (figure 1).

In relation to these three types of approaches, we propose **QUASI_NATURAL** forms as the forms resulted by taking the approach of this paper to design. In figure 1 it is shown that this type of forms stand above the organic group of forms and closer to natural forms. It means that these forms have more properties in common with original properties of natural forms; it is because of less abstraction and more realistic approach to the natural forms (figure 1).

The Theory of Form

The approach of this study to the form issue is as follow.

- The first principle of this Theory is ignoring the traditional geometric-quantitative approaches to the nature. Therefore, the mind would ignore presupposes and traditional expectations for finding orders and patterns. Following this, the nature would not be limited merely to fluidic or curved forms or merely geometric and linear ones, but all types of forms would be considered and with their original properties. In other words it is tried to look at the nature as the way it is.
- Each of natural phenomena is considered as a designed one. It means that all details are important and has direct effect on final shape. Therefore, considering all details of forms as intentional created parts is another important principle.
- Although our observations have been based on non-abstraction approach, it should be mentioned that abstraction is unavoidable. Here we have just tried to apply less degree of abstraction in order to get closer to the reality.
- We do believe on the analyzing capacity of geometric reasoning and geometric forms, therefore geometric reasoning would be applied for analyzing the action of the forces (As it is explained in the following); but would not have apparent manifestation in Quasi-natural forms.
- Taking this kind of approach to the nature, complexity is the first quality appears to us. It is not tried to understand complexities of forms by finding and extracting patterns or orders in them. Instead it is tried to generate a clear and tangible definition about the logic of complexity. A definition which helps designers to think about the complexity as complexity.
- Gestalt was explained as "An arrangement of parts which appears and functions as a whole that is more than the sum of its parts" (Monö, 1997). The position of this study to

the gestalt is based on the interaction of all elements of form (Line, Volume, Color, etc.). Our studies showed that all elements of forms in nature affect each other bilaterally and the unity of final whole is the result of their interaction. All elements are exposed to the forces from each other and this is how the final unified shape appears.

- The involvement of this approach with different aspects of form theory is shown in figure 2. Visual aesthetics and emotional aspects are the most involved areas. In other words this approach would mostly affect these two areas in the sphere of form theory.

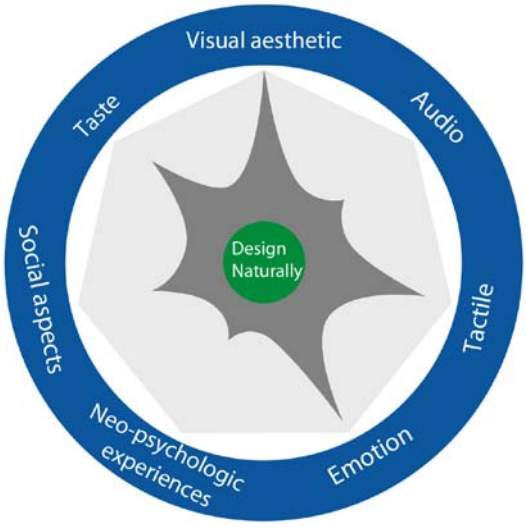

Figure 2 Different issues concern with form theory & involvement degrees of Design Naturally approach with each of them.

Objectives & hypothesis

This paper aims to

1. Study the reality of forms in nature, which is manifested towards complexity, by avoiding reductionism.
2. Present nature's approach to the form issue and its manifestations as applicable tools for designer.

Our hypothesis is that this approach would take us beyond the law-bound principles of geometry and would create a new aesthetical language to the world of products based on the real complex world.

Method

Case study

A case study was performed to study specific target group of natural phenomenon in order to find out nature's real complex approach to the form issue. The geometric reductionism, aesthetical norms, interests and presupposes were avoided and it was tried to see the forms in the way they really are. Thus we encountered with COMPLEXITY of forms and their relating characteristics such as, unpredictability, irregularity, asymmetry, etc. Apparently it was

understood that nature's approach to the form is DIFFERENT from designers one. In fact, when we observe forms in nature we can follow some principles that are embedded in their design and it seems that they are not the same as the principles that designers use in shaping the artificial forms. These principles are those which produce visual complexity of natural forms. The target group was consisted of several types of birds and reptiles and few types of plants. The reasons for choosing such a target group was firstly due to the sake of birds' and reptiles' great variety in form and secondly due to the accessibility of plants for virtual study. We focused on principles behind the formation of forms in nature and the ways we defined them for designers.

The study started by observation and realistic drawings. In first phase, 10 types of birds, 6 types of reptiles and 12 types of plants were observed. The materials for observation were pictures, movies and also virtual observations. Some of the pictures were selected from the internet and books and others were taken by digital cameras.

The visual characteristics of each sample were carefully studied. Then detailed explaining notes and drawings from each of them were made (Figure 3). By this phase we could recognize some almost constant characteristics, which seemed to be common in all observed samples.

Figure 3 Drawings from birds

In Parallel with observations, a library search regarding the scientific aspects of form generation processes in nature was performed to find out the reasons behinds the visual qualities. It was also tried to obtain a general explanation for defining the observed characteristics.

The aim was to find out about the possibility of considering the observed visual characteristics, as constant principles, which nature applies to create forms. For this aim, there was a need for studying many samples. Statistical operations performed to determine the sample size of each of the target groups. High percent of common characteristics in first observations showed that studying 20 types of each of the birds, reptiles and plants would be enough to obtain decisive results about the final principles.

Results

The results are categorized in two parts.

1. Form Follows NATURAL Interaction of Forces: An explanation about how COMPLEXITY appears in natural forms.
2. Manifestations of this explanation in natural forms.

Form Follows NATURAL Interaction of Forces (FNIF).

This is our perception from how complex forms appear in NATURE. This sentence can simply and generally explain some complex qualities of forms in nature such as asymmetry and unpredictability. We believe that taking this approach to product design would cause these qualities to appear in products too.

The word "Force" refers to both Directional and surrounding energies. Directional forces refer to the energies acting upon the movement of the inner & spacial axis of form and its elemental parts. These forces increase the complexity and asymmetry in forms by affecting the surface from beneath and above and with different angles and intensities. The pressure or the tension of the force is absorbed by the positive element and then projected outward through the form and into space (Akner-Koler, 2007, 19). For instance they may cause curves, bends, concavity, convexity and wrinkles.

As a complement to directional forces, surrounding force is defined. Each element of forms in nature is surrounded by a type of energy which can affect the form of its adjacent elements. To some extent, it is comparable with invisible magnetic field of the magnet, which affects the iron filings around it or the layers of the energy surrounding every living thing (Figure 4).

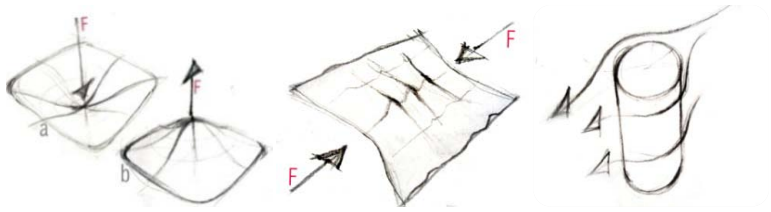

Figure 4 On the left: Directional forces cause concavity & convexity, in the middle: Directional forces cause wrinkles, on the right: Surrounding forces of the cylinder affect its adjacent axial forces.

Interaction of the forces refers to their bilateral relationship and its effects that shape the form. The quality of the interaction of the forces is defined by the word "Natural" which is the key word here. Longman dictionary has defined this word as "concerning, existing or happening ordinarily in the world (nature), especially not caused, made or controlled by people".

In conclusion, FNIF is pointing to "What ordinarily happens by bilateral relationship of directional & surrounding energies affecting axis & constituting parts of form". For example, crumpled piece of paper is the natural result of interaction of the forces applied by fingers to it. Also in figure 5 two forces contract a cylinder by asymmetrically pressing against the two base surfaces of it. It can be seen that two common traits of natural forms, chaos and asymmetry, has naturally appeared in this form via natural interaction of forces.

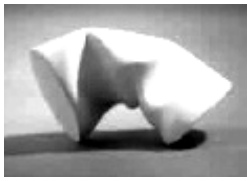

Figure 5 Complexity, the result of natural interaction of the forces

Manifestations-Design Naturally Principles (DNP)

FNIF has variety of manifestations in nature. Here they are categorized into 5 groups of line, plane, volume, color and texture. Each group explains how nature applies that specific element of forms regarding to FNIF dictum. These principles are like toolkit which can guide designers to apply elements of forms as nature do. Here they are presented under the title of DESIGN NATURALLY Principles.

The following principles are all based on one fact: Adjacent elements naturally affect each other and this bilateral effectiveness causes some changes in their forms. These changes which are mostly towards complexity, appears as the results of natural interaction of the forces.

Line

Line changes by form. These changes mostly appear in weight of line (thickness), its direction and sometimes, its color. The reason behind these changes is the forces from the context (plane) and other adjacent elements which affect the line through its path (Figure 6). Here two more common situations are presented.

Figure 6 Changing weight of the black line, regarding to its context

First is about the changes of line when it moves on different surfaces (e.g. concave or convex surfaces). When the line passes the concavity or convexity, naturally, the directional forces which have affected these surfaces and have made them curved, would affect the line too. So, naturally the line would become thick or thin (Figure 7) or temporarily get out of its direction.

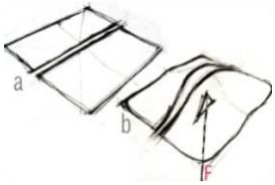

Figure 7 Line on convexity naturally becomes thicker (b).

Second situation, is about the changes of line when it becomes adjacent with other elements through its path. For instance in figure 8. It can be seen how the surrounding forces of the bump on a tree have changed the direction of its adjacent lines. The form of the deviation depends on the form of the element, its size, the quality of lines and their distance from each other.

Figure 8 Surrounding forces of the bump on a tree have changed the direction of its adjacent lines.

Line changes the form. Regarding to the bilateral relationship of elements in nature, in some situations it can be seen that line affects its context and other adjacent elements too. For example in figure 9 the slight depression and change of color around the mid rib and each of the veins as lines, on the leaf, as their context (plane) are visible.

Figure 9 Line changes its context

It can be concluded that line changes freely by form and on the other side can change the form too. This dynamic and changing quality of line is what exists in nature but not in man-made products (Figure 10).

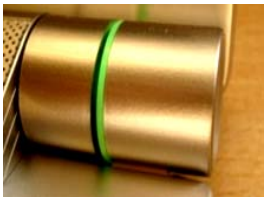

Figure 10 An unchanged quality of line when it passes a convex surface of a cylinder

Plane

Plane changes by its constituting parts. Plane prepares a field in which other elements can be defined. According to the bilateral relationship between the adjacent elements, we can say that plane is exposed to the directional and surrounding forces of the elements concluded. So the final shape of the plane depends on the result of natural interaction between all these parts.

Cutting, removing or adding an element, creating unevenness, or applying any other kind of change on a plane, is in fact equal with implementing a type of force to it (Figure 11).

Figure 11 It can be liken to effects of a drop on water.

Natural interaction of these forces would have some manifestations which depending on the forces' properties, would differ. An eye of a bird on her face can be a good example for this. In figure 12, some wrinkles and slight bump around the eye of bird on its face can be seen. These are caused by the directional and surrounding forces of the eye as an added element, on the face as its context.

Figure 12 The complexity of the white area

Regarding to the scope, angle and the strength of the acting forces, other manifestations such as depression or a bump, change in color or texture, wrinkle or even a dent are also expectable (Figure 13).

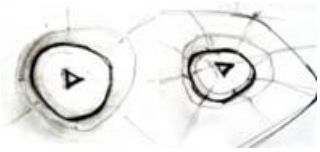

Figure 13 An added play button and its effects on a surface

As mentioned before, plane in nature freely changes by the forces acting upon it. The contour line of the planes also forms by the interaction of these forces. Figure 14 shows how surrounding forces of the inner elements have formed a complex and unpredictable contour line. This is why we rarely encounter with pure geometries of planes in nature.

Figure 14 Unpredictable contour line

Edges are specifically identified. Edges mostly form under the pressure or tension of the concentrated forces. Therefore according to FNIF dictum, it can be seen that in natural forms, these areas are almost always identified by some visual traits such as Wrinkles, constriction, change in thickness or the color and texture (Figure 15).

Figure 15 Change of color, texture and thickness on the edges of duck's bill.

Above-mentioned principles also apply to the "points" as scaled planes.

Volume

As volumes form by combination of the planes, all of the principles about the planes apply to volumes too.

- Volume changes by its constituting parts.
- Volumes don’t appear in their basic forms.

- Edges are specifically identified (Figure 15).

Joint areas are almost always identified by some visual traits. Joint areas in nature can usually refer to where one volume comes out of the other. Growing out a volume from the other one in fact means implementing force from inside, until the volume finds its way to get out. Interaction of pushing and opposite forces would naturally cause some changes to appear in joint area and in both volumes. Figure 16 shows how the petiole has grown out from its stem. Soft tonality of colors and constriction of parts which express contradiction of forces and also transformation of one volume to another can be seen in figure 16.

Figure 16 When a volume comes out from another one

Generally, when two volumes join together, it means that two or more opposite forces are interacting. Change in color, wrinkles, constriction, or a kind of puff are symptoms of this interaction. The changes in joint of volumes would differ due to the direction of axial movements, size and strength of the forces of the meeting volumes.

Texture

In nature texture changes by form and emphasizes on the quality of form. Texture is one of the characteristics of surface. It has a dynamic nature and should change by the changes of the surface. The directional and surrounding forces, which act upon the plane (surface), naturally affect its texture too. Therefore, for example the quality of texture of the concave surface surely differs from the same texture on convex one and also from the texture on the edges and joints (Figure 17). Designers mostly don't consider this point in their designs. Figure 18, is a picture of a product which presents texture that has covered a curved surface. As it can be seen, there is no meaningful relation between the texture and the curved surface beneath it. All elements of the texture are constant, no matter how the surface changes.

In conclusion it can be said that in nature texture changes freely due to the changes of its context. Therefore, it would find a dynamic characteristic which emphasize on the quality of form.

Figure 17 Dynamic texture in nature - All elements of the texture change by convexity and concavity of surface and also at the edges.

Figure 18 Texture in products

Color

Color changes by form and emphasize on the quality of form. Figure 19 shows the thorn of a rose. As the thorn gradually becomes sharp-pointed at the end, its color also changes softly from dark red to light yellow at its sharp end. This tonality emphasizes on the form of the thorn (sharpness) and is one of the other manifestations of the complexity in nature. Color has a dynamic nature and should change by the changes of the surface. Due to FNIF, the acting forces upon the surface naturally affect its color too. For instance, concave, convex, edges and joints are places which pressure and tension of the forces naturally cause changes in colors (Figure 20). We can also trace this phenomenon in some of our every day products, (Figure 21). Though designers mostly don't consider this matter (Figure 22).

Figure 19 Thorns of rose bush

Figure 20 Mushrooms, Color changes on concavity

Figure 21 Blue jeans - Abrasion of the edges are the result of natural interaction of forces. Great relationship between form and color

Figure 22 A watch by Ross Lovegrove Plane color, No matter how the form changes

Above-mentioned principles are in fact the manifestations of complexity of forms in nature. Unpredictable contourlines, tonality of colors, dynamic textures, changing quality of lines, non-geometric planes and volumes, asymetrical compositions and so on, are all those visual items, which make nature complex in front of our eyes. FNIF dictum is an explanation which generally help us to understand these complexties and analayze them by the interaction of the forces. Besides, as you know, almost all of the above–mentioned principles are those items which have been ignored previously by designers because of their common geometric approaches to the nature BUT have values to be applied in product design.

Our point here is that Applying Design naturally principles would provide designres a vast realm of creativity and freedom in field of forms. It would grant a dynamic identity and new aesthetical values to all elements of forms, meaningful relationship between them and more sense of integrity to the whole complex.

To design naturally, first we have to think naturally!

As a complement to DNP we need to know about the process which by nature has applied DNP. This process is known as GROWTH. By the 'Growth Process' in nature we are referring to the process in which different parts of a phenomenon gradually appear till it attain to puberty. This is during the growth process which directional and surrounding forces work and so the above-mentioned manifestations appear (by the natural interaction of the forces).

In order to design naturally (apply the design naturally principles), we need to be able to think naturally. Transferring the concept of growth may help designers to do this.

Our studies are still in progress in order to generate a method based on the natural growth, to enable designers to:

- Think about the form-giving process as a growth process of natural phenomenon
- Analyze the acting forces and their natural interactions through the form-giving process
- Apply the DNP regarding to analysis of natural interaction of forces

Conclusion

After all it can be concluded that by looking through the complexity of forms in nature and by forgetting the geometric approaches, we would be able to get closer to the reality of forms to learn more and deeper from nature. Thus we would be able to go far beyond the law-bound principles of the geometry and traditional design aesthetics and create a new aesthetical language to the world of products based on the real complex world.

References

Akner-Koler, C. (2007). *Form & Formlessness,* Sweden: Chalmers tekniska hogskola.

Alexander, C (1964). *Notes on the synthesis of form*., Massachusetts: Harvard University Press.

Arnheim, R (1969). *Visual thinking*. Berkeley: Univerisity of California Press.

Banger, A. (2004). *Fifty years of designing the future*, London: Thames & Hudson Ltd.

Bertelsen, S. (2004). *Construction Management in a Complexity Perspective,* 1st International SCRI Symposium, March, UK.

Bois, Y. A. (1997). *Base materialism. In Formless. A user´s guide*, New York: Zone Books.

Frangmyre, T, Heilborn, J. L & Rider, R. E. (1990). *The Quantifying Spirit in the 18th Century*, Berkeley and Oxford: University of California press.

Gleick, J. (1988). Chaos: *Making a New Science,* New York: Penguin.

Greet-Hannah, G. (2002). *Elements Of Design: Rowena Reed Kostellow And The Structure Of Visual Relationships,* New York: Princeton architecture press.

Habermas, J. (1998). *Modernity - an incomplete project*. In *The anti-aesthetic. Essays on postmodern culture*, ed. Hal Foster. New York: The New Press.

Heskett, J. (1993). *Industrial Design,* London: Thames and Hudson Ltd.

Lovegrove, R. (2004). *Supernatural: the works of Ross Lovegrove*, London: Phaidon Press.

Mehly, B, Pernodet, P & Colani, L. (2001). *Luigi Colani,* New York: Distributed pub Inc.

Monö, R. (1997). *Design for Product Understanding: The Aesthetic of Design from a Semiotic Approach,* Stockholm: Liber förlag AB,.

Nasr, S,H. (1997). *Man and Nature: The Spiritualistic Crisis of Modern Man,* Chicago: ABC.

Nasr, S,H. (1996). *Religion and the Order of Nature*, Oxford: Oxford University Press.

Procter, P. (1978). *Dictionary of Contemporary English,* Germany: Long man Group Ltd.

Rampell, L. (2003). *Designatlas. En resa genom designteori 1845 – 2002*. Stockholm: Gabor Palotai Publisher.

Rotzler W. (1977). *Constructive concepts*. *A history of constructive art from cubism to the present.* Zurich: ABC Edition [Rizzoli].

Tillberg, M. (2003). *Coloured universe and the Russian avant-garde. Matiushin on colour vision in Stalin´s Russia 1932*. PhD thesis. Stockholm: Dept. of Art History, Stockholm University.

Trotto, A, & Cianfanelli, E. (2006). *Beyond bionics - a tool of innovation, optimization and ecology,* DeSForM Conference, October, UK.

Verneaux, R & Wahl, J, A. (2009). *Histoire de la Philosophie Conteporaine: Philosophies de l' existence,* Translated by Mahdavi, Y., Kharazmi pub., Tehran.

Wrathall, M. (2005). *How to Read Heidegger*, ed. Critchley, S., New York: W. W. Norton & Company.

Wyte, L, L. (1968). *Aspects of Form: A Symposium on Form in Nature and Art*, London: Lund Humphries, second edition.

Author Biography

Parsa Kamehkhosh is student of master of industrial design at university of Tehran. His main research interest is chaos and complexity in form theory.

Alireza Ajdari got his B.A. and M.A. in Industrial design from university of Tehran, Iran and has got his Ph.D. in Industrial Design and Multimedia Communication from Politecnico di Milano in 2008. Since then he has been working as an assistant Professor in Industrial Design in University of Tehran, Iran. His main research interests are the role of Cultural Affordances in product Design and form theory.

Yassaman Khodadadeh is an Associate Professor of Industrial Design and Head of Department of Industrial Design of Kish International Campus of University of Tehran. She received her PhD from Keele University, UK. She is a member of Design Research Society (DRS) and an active researcher in field of Design.