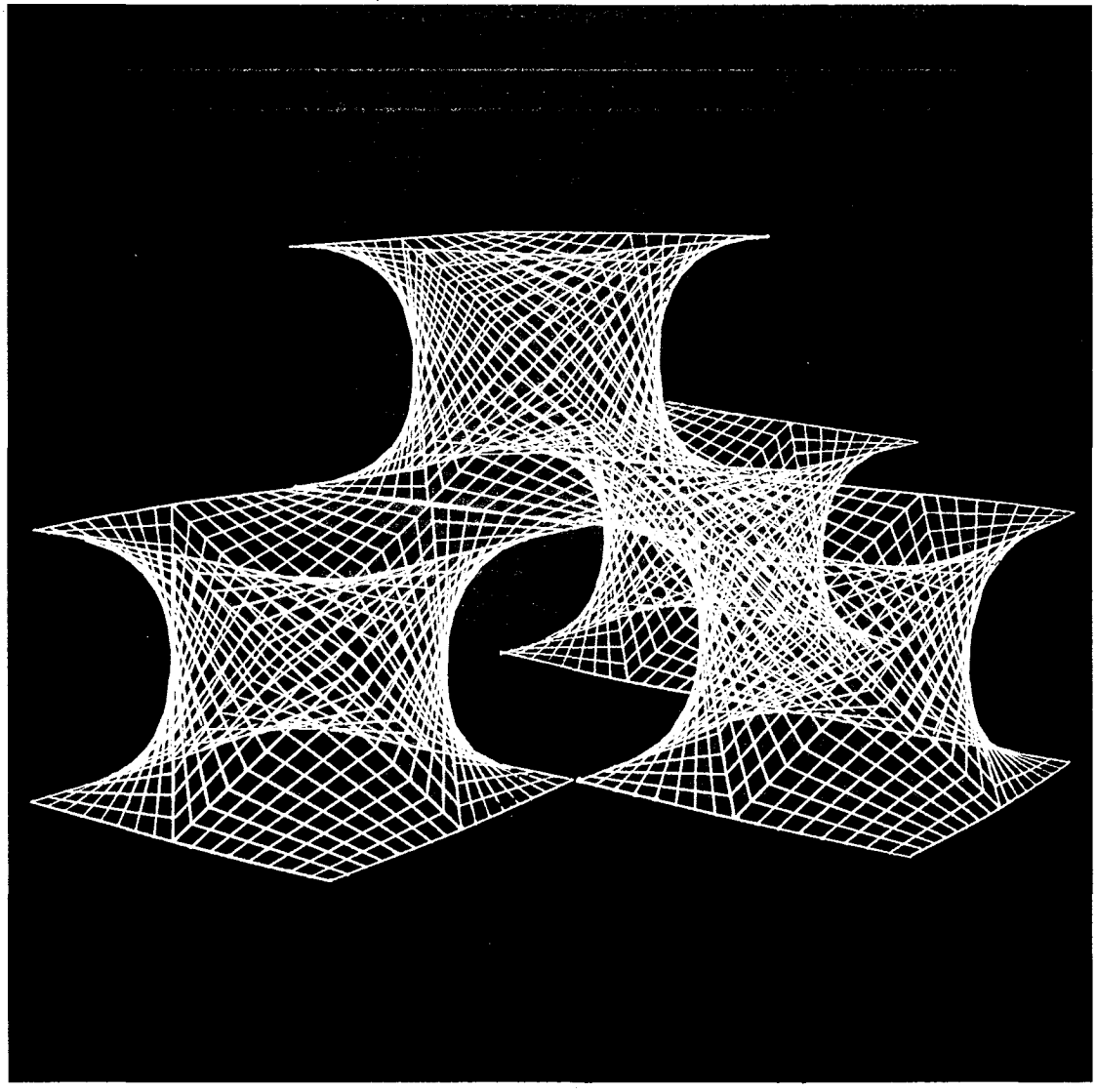
Symmetry: Culture and Science

ORDER / DISORDER
Proceedings, 4th Congress

The Quarterly of the
International Society for the
Interdisciplinary Study of Symmetry
(ISIS-Symmetry)

Volume 9, Numbers 2 - 4, 1998



Symmetry: Culture and Science
Vol. 9, Nos. 2-4, 135-142, 1998

PHYSICAL ASPECTS OF ORDER IN VISUAL COMMUNICATION

Giuseppe Caglioti

Address: Dipartimento Ingegneria Nucleare, Politecnico di Milano and INFM - Politecnico di Milano. E-mail: caglioti@axp7000 cdc.polimi it, giuseppe caglioti@polimi it.

Keywords: *order, reduction of symmetry, symbols, perception, quantum mechanics.*

Abstract: *The forms of order encoded in some visual messages falling everyday under our eyes are analyzed and their impact on our perception is discussed. The fact that well structured visual symbols or messages are immediately and unambiguously interpreted irrespective of language or cultural biases is ascribed to the universality of natural laws: both the designer (emitter) and the perceiver obey natural laws; the professional designer engaged in the creation of a visual message finalized to promote a specific reaction instinctively finds the way to inject in it the specific forms of structural order enabling the image to fulfill its mission; since these forms of order are inspired by natural laws, the receiver can decode them easily and promptly while unraveling the meaning of the message during the process of perception.*

1. INTRODUCTION

Non verbal communication, based, e.g., on visual (or acoustic) images, is becoming more and more important in our global society. Nowadays people travel more than in the past. More often than in the past they change their country of residence or even their nationality. Society is becoming multiethnical and increasingly complex. Good social relations are necessary for its survival. And yet, as in the past, language barriers continue to hamper mutual understanding.

More and more frequently recourse is made to visual communication. Think for instance to traffic signals and to computer icons: here information must be transferred quickly, irrespective of the mother tongue of the perceiver. Fortunately, in practice, in most cases the visual message, even if it is structured in abstract form, proves to be clearer and more effective and immediate than the verbal message conveying the same meaning.

Visual messages are indeed universal. Like music, they overcome language barriers, they don't need to be translated in order to be grasped. We are tuned on them, we resonate with them, while in order to interpret their corresponding verbal message - whose understanding, in any case, requires some knowledge of the specific language in which it is expressed - we need much longer time.

What are the reasons for that *universality*?

The fact that well structured visual images strike directly and promptly our perception, the fact that they lend themselves to an unambiguous unraveling of their meaning implies that the *forms of order* embedded in their structures are archetypal and in most cases independent of the local culture of the designer.

Somehow the designer creating an icon or a traffic signal, finalized to promote a specific reaction, instinctively finds the way to inject in it the forms of structural order enabling the image to fulfill its mission.

The objective of this contribution is to show that *ultimately the designer's capability to create universally understandable images can be ascribed to the universality of the natural laws.*

Irrespective of the medium (visual, acoustic, ...) we use to communicate, we obey the laws of nature and instinctively apply them. Consequently the designer who is more faithfully capable to interpret the natural laws shapes the structure of his message in such a way as to orient the reaction of the receiver - who also promptly obeys natural laws instinctively - according to the function inspiring the message itself. While doing so he acts biologically, stimulating directly our sensory organs, without hindrances and slowdowns created by cultural biases such as those prevailing in the formulation of a verbal message in a specific language.

In this perspective, the intimate reason for the prompt, mutual understanding between the designer (emitter) and the perceiver of a visual message could thus be identify in the fact that they both operate on the common ground of the natural laws: the designer - most frequently by instinct - encodes such laws in his message and the receiver decodificates them while unraveling the meaning of the message during the process of perception.

2. THE ZEBRA CROSSING: AN EXAMPLE OF DISCRETE TRANSLATIONAL SYMMETRY IMPLYING *AND REQUIRING TO THE PEDESTRIAN* CONSTANT MOMENTUM (OR VELOCITY)

Recollecting our childhood, most of us remember the warning of our parents: *don't start running while crossing the road!*

The visual counterpart of this recommendation is faithfully codified in the form of structural order characteristic of the zebra crossing. (Fig. 1)

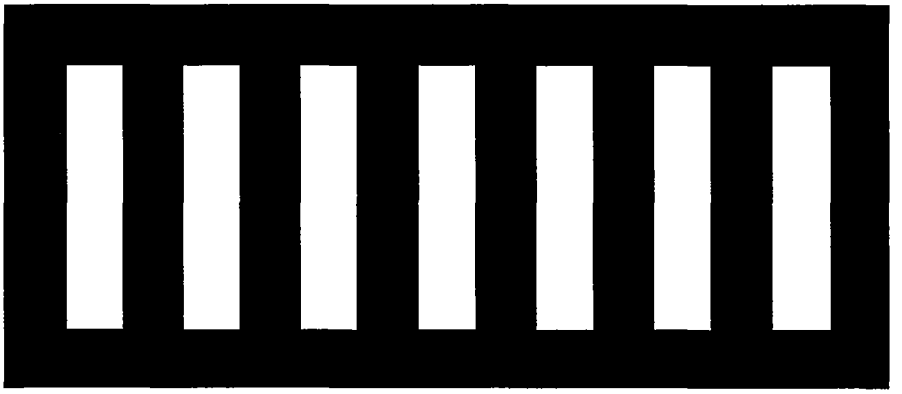


Figure 1: The zebra crossing

In fact the structure of this visual message is obtained by *reducing* the continuous *translational symmetry*, typical of the homogeneous dark gray coloration of the asphalt, to discrete translational symmetry: on the homogeneous coloration of the asphalt *any* translation - irrespective of its size - is a symmetry translation (so that once we have made the translation we are not aware of having made it); on the zebra crossing instead,

only the discrete translation whose lattice spacing is the width of the white &dark-gray pair of alternating slabs is a symmetry translation. It is indeed this continuous → discrete translational *symmetry reduction* which is responsible for the *order* imprinted in the zebra crossing. But symmetry - a no change as the outcome of a change - is synonym of invariance. At any symmetry element in a structure corresponds a dynamical observable generating the symmetry element itself (we allude here to the so called constants of motion), an observable which keeps constant its value. A discrete translational symmetry is associated to a discrete set of possible constant momenta or, in practice, to a discrete set of constant velocities. Most naturally then, the order imprinted in the zebra crossing is perceived by the pedestrian as an order - or at least a strong recommendation - to maintain a constant pace without abrupt acceleration.

It might be appropriate at this point to recall that analogous arguments apply also to other media and to messages of different nature.

For instance, the repetition of the musical theme in a baroque fugue can be envisaged as a discrete translational symmetry of the structure of the score. And the word *fugue* evokes indeed a constant velocity.

Furthermore in his poems, in order to evoke constant velocity, Virgil systematically adopts pentadactylic hexameters. Try, e.g., to follow the rules of the metric (ictus on the bold type vowels at the beginning of any meter) while reading loudly

DUcite ab | Urbe do | mUm mea | cArmina | dUcite | DAphnin

or

QuAdrupe | dAnte pu | trEm soni | tU quatit | Ungula | cAmpum,

With easy gait, your mind will accompany Daphnia running away from the city back to his lover or, assisted by onomatopoeia (namely, here again, by the order associated to the discrete translational symmetry typical of the rhythm), will build the vivid mental image of a horse at a gallop.

The above examples indicate how order arises when translational symmetry is reduced from continuous to discrete. In general, *reduction of symmetry generates order* This aphorism applies to the whole range of conceivable scales: from the macroscopic scale of the objects perceived by our sensory organs all the way down to the atomic scale of quantum physics and subnuclear particles. However symmetry arguments are qualitative in nature and apply not only to all scales - allow me to insist on this crucial point - but also to all conceivable processes: to processes occurring around us in nature as well as

to mental processes, such as perception, occurring in our brain (a brain which too is part of the nature.)

3. ANALOGIES BETWEEN THE MENTAL PROCESS OF PERCEPTION AND THE PROCESS OF MEASUREMENT OF QUANTUM STRUCTURES

In a previous paper presented at the ISIS-Symmetry Symposium at Tsukuba (Caglioti 1995), I have proposed that perception can be envisaged as an irreversible ordering process developing in our mind. During perception, the mind, driven by curiosity and attention, interiorizes the proposed image and controls it. The interiorized image evolves from a balanced, statistically symmetric and disordered state, where the stimuli suggested by the proposed figure act initially incoherently, to an unbalanced, more and more ordered state. As a result of this evolution, through a nonequilibrium dynamic instability our mind undergoes a disorder-order transformation, from a meaningless ensemble of uncorrelated signs, to *ordered thought* or *visual thinking* (Arnheim 1969). Incidentally, nothing, perhaps, is more ordered than the thought, notwithstanding the chaotic though statistically selfsimilar pattern of our encephalogram. At the critical point of this dynamic instability the interiorized image eventually comes into coincidence with the archetype of the proposed image, genetically or culturally impressed in our mind. Since the moment this critical state has been attained, the interiorized image behaves as a single entity reminding the quantum mechanics collective, macroscopic wavefunction describing e.g. the laser action resulting from the Bose condensation of the photons of an electromagnetic field optically pumped sufficiently far from thermodynamic equilibrium.

In the Tsukuba contribution quoted above a detailed analysis has been produced of the process of perception of a bistable ambiguous figure obtained by a *graphic condensation* of two cubic moduli. It was concluded that an analogy can be proposed between that perception process and the spectroscopic measurement of the charge transfer spectrum of the hydrogen molecular ion according to quantum mechanics: the analogy turns out to be so stringent that one feels confident to infer from it that the logic underlying the process of perception is the same as the logic of quantum mechanics. In quantum mechanics (as well as in the synergetic behavior of collective nonlinear open systems (Haken 1983)) a central role is assigned to the onset of order produced by symmetry breaking or symmetry reduction (as well as to ambiguity, i.e., to the confluence and coexistence of two incompatible aspects of a same reality - think, in

particular, to the coexistence of order and disorder at the critical state of an equilibrium order-disorder transformation or a nonequilibrium dynamic instability.)

In this perspective, extrapolating a bit the above arguments, in what follows we propose that the mental process of perception and the process of measurement in quantum mechanics are governed qualitatively by the same formal rules.

4. THE PRINCIPLE OF INDETERMINACY AND THE TRAFFIC SIGNAL JUST PRECEDING A ZEBRA CROSSING: A REDUCTION OF THE DISCRETE TRANSLATIONAL SYMMETRY IMPLYING *AND REQUIRING TO THE DRIVER* A DECELERATION WHILE APPROACHING A PEDESTRIAN CROSSING

One of the most important characteristic of the process of measurement in quantum mechanics is the existence of an insuperable limit for the accuracy in the simultaneous measurement of pairs of observables whose product identifies an action: for instance it is impossible to measure simultaneously and exactly the position in space of a point-like material particle and its momentum (momentum is the product of mass by velocity) or to determine with unlimited accuracy its energy at an infinitely well known specific time, etc. The *indeterminacy principle* states that the product of the uncertainties in position and momentum of a particle cannot be lower than the Planck constant, the elementary action h.

If, via a measurement, we pretend to localize a particle with great accuracy, we cannot pretend to keep it still. Vice versa, if we want to keep a particle still, we must be ready to accept a large uncertainty in its position.

The above principle could help perhaps to assess the deep reasons underlying the pattern, reproduced in the previous page, of another traffic signal recently appeared along the European road network.

Every driver interprets instinctively this signal as a firm invitation - an *order* - to slow down, so allowing pedestrians to cross the road safely as the car approaches the zebra crossing. Here again, most likely, the order *slow down!* emitted by the visual message above is received correctly and promptly because of the fact that the form of order in the structure of the visual message itself is consistent with the qualitative implications of the natural laws of symmetry and of the indeterminacy principle.

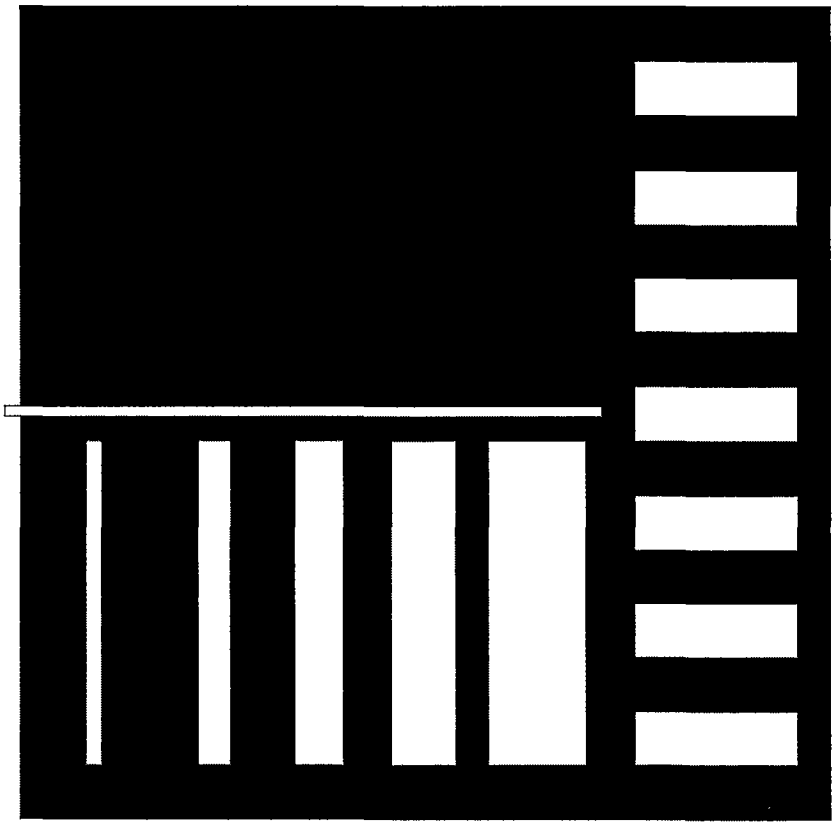


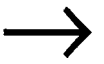
Figure 2

In fact the visual message can be conceived as obtained from the zebra crossing by altering the widths of the alternating white and dark-gray strips. The resultant succession of five white strips of increasing width, could be thus conceived as generated by an additional reduction of the discrete translational symmetry that in the zebra crossing evokes constant momentum and pretends a constant velocity by the pedestrian.

However, any symmetry reduction in a structure produces a form of physical order. Since translational symmetry implies constant momentum and pretends a constant velocity by the pedestrian, a change of lattice spacing implies a change of momentum and pretends a change of velocity by the car driver.

That this driver's velocity change should correspond to a *de*celeration is qualitatively suggested by the indeterminacy principle: according to it, thin strips correspond to large momenta (or velocities) while thick strips, near to the zebra crossing, correspond to small momenta (or velocities).

Similar arguments do apply to the ubiquitous visual message of the arrow:



Here again the eye, after having loitered lazily on the body of this symbol (large space corresponds to low velocity) is instinctively brought to fly away as fast as possible from the pointed arrow's tip.

5. CONCLUSION

It is a pleasure to conclude this contribution with the visual message shown after the References.

REFERENCES

Caglioti, G (1992) *The Dynamics of Ambiguity,* New York: Springer-Verlag. (also available in Italian (CittàStudi1994 (2nd edition)), German (Wieveg 1990), Japanese (Kodansha 1997) and Russian (MIR 1998) editions)

Caglioti, G. (1995) From Perception to Thought, in *Katachi ∪ Symmetry,* Tokyo: Springer-Verlag.

Haken, H. (1983) *Synergetics. An Introduction.* 2nd edition, Springer-Verlag.