Architecture as Drawing, Perception and Cognition
Background for an exercise of computer modeling applied to the Church of Sta. Maria de Belém - Lisboa

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Abstract. *This work is about realizing that human perception is inherent to architecture. It is an asset and a trait subject to training and development in an empirical way, involving physical and manual action. It cannot be taught literally through convention and logic reasoning. It is a human achievement of great significance built on intellectual and scientific knowledge. It is something, being physical and empirical, that is supported on instrumental procedure. The computer, as a machine and an instrument, does not shorten the empirical experience of manipulation; on the contrary, it enhances J.J. Gibson's findings about the perception of space in relation to eye and body movement.*
Being a cybernetic machine the computer may, and shall, evolve, and become perceptive. In order for that to happen, it is important to keep in mind the mechanism of human perception.
Through producing a computerized model of a major architectural work, we develop natural knowledge about its physical features and the thought that lies underneath. To be able to use the computer as an instrument provides a user with explicit knowledge about its ways and mechanism that has to be made available. It involves training, which is to a great extent self-explanatory, and also explicit knowledge about the conventions that are being used, such as programming, reasoning and trigonometry.

Keywords. *Visualization; Environmental Simulation; Knowledge Modelling (KM); 3D Modeling.*

Norm Images

The active role played by perception on cognition, as conceived by Arnheim (1969), does connect to Guilford's (1967) theory on the Structure of the Intellect. As much as Norberg-Schulz's (1967) writings about a Theory of Architecture, his ideas were also drawing on Piaget's (1947) findings about the way sensory-motor activity develops to build one's mental schemes, which in turn articulate into more complex mental constructs that we call cognition. Guilford develops his theory based on the scientific possibility of measuring in a precise and objective manner from standard tests, a set of intellectual faculties called factors and represented on his Structure of Intellect Model.

While dealing with the necessity of having scientific rigor, as stated in his Psychometric Methods (Guilford, 1936), he also acknowledged the phenomenological reduction with his writing on Qualitative Descriptions (Guilford, 1967), where the phenomenological could be dealt with. Being concerned with the necessity for objectiveness that should assist any scientific proceeding, he was aware of the difference between a mathematical representation and the need for indicators from the actual world that we live in, the observable world. Calling upon the mythic dimension of a mathematical infrastructure over which events take place in the world, Guilford was addressing what had been the basis for a theoretical representation of architecture (Guilford, 1936). His statement is that mathematics is a human invention and not a real discovery, and its adjustment to events, making possible their prediction, is, first of all, a convenient coincidence.

Just as much as Arnheim would do, Guilford underscores that associated with intellectual development, the capacity to find visual constancy over the changing shape determined by changes in context of what was initially considered a single unitary object, and the capacity to associate in homogeneous classes, similar unitary objects become existent.

The basis for that discovery is both visual and analogical. Not on some a priori symbolic way, but as if there was visual reasoning where prediction could be made, comparable to mathematical modeling.

Objects have surfaces, contour, dimensions, and distance These become variables in vision correlated to the reality (figs. 1 and 2).

Arnheim (1969) associates perception (the images of thought) with the building of cognition stating that there is a link between thought and perception. Good perception means that we can read from the object perceived the pertinent generic features, the ones that assemble the skeletal structure of an image, and this ability is not without active thought. Being able to perceive a visual structure from visible images is being able to build abstractions, and that is the basis for perception and the start of cognition. Susanne Langer (1942) refers that this kind of abstraction comes through a disposition of imagination to isolate the significant examples from a general context, and to reapply them, through interpretation, to other conditions found in reality. Unlike Susanne Langer, Arnheim does not think that this work being done by thought from visible material (which Langer calls representative abstraction, as opposed to science's generalizing abstraction) is a sole feature of artistic performance. He thinks that the ability that scientists have to sample a set of cases prior to reaching conclusions is also representative abstraction. There is also in science an insight about what is going to be concluded, a formulation originated in Morris Cohen and Ernest Nagel (1934) work.

This idea is then illustrated with the visual imagination involved in Copernico's astronomical model.

Images of thought thus have a quality that distinguishes them from an exact reproduction of all physical features of the object being perceived, and this is some degree of incompleteness. The fragmented images with which the mind operates,

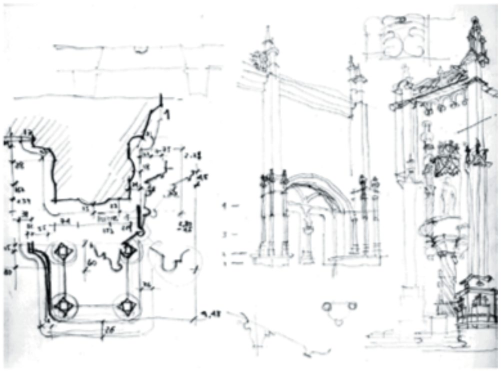

figure 1. Literal vision; identifying surfaces and contour.

figure 2. Descriptive dimensions and representation.

are such because this fragmented character is a positive quality produced by the object's mental apprehension, allowing for one's ability to mentally process visual input, which is different from exactly determining an object's tangible and material dimensions. Gestalt psychology had already stated this idea with the temporal Gestalt (Kofka, 1935). One conclusion to be drawn from this observation is that the fragmented pieces withdrawn from visual representation convey a bone like structure of dynamic traits that plays an essential role on mental operations such as abstracting, producing generalizations, and classifications.

It is important to emphasize that, although fragmented, these images are visual constructs and not just the result of conventions, i.e. a difference addressed in Gibson's (1950) distinction between schematic perception and literal perception. The condition that assists the images of thought is that they are structurally similar to the actual images (fig. 3).

figure 3. Visual construct

Seeing as science

Psychology has told us that the capacity to respond to problems aroused by our environment, or to develop knowledge about that environment, is built upon the existence of 'norm images' (Arnheim 1969). The problem with this statement is that, at first, it seems too simple, as if not rational or not proceeding from an intellectually valid discourse.

From the start, the term 'norm images' gives this notion a connotation with the ability to see, as painters, sculptors or architects see, and at the same time it engages some distance with activities that we normally do not associate with a predominance of 'seeing', as the scientific, engaged from mathematical and statistical manipulations, or the writing of a novel or an essay. What it actually means is that every act of perception calls upon the possibility to associate the event being perceived with a visual concept which is the stock of previous perceptions treated as structured images being recalled as apt to being applied to that event, i.e. a process calling upon memory, classified as recognition.

Architects are normally considered the scientific artists, a role that while addressing the type of synthesis which is tackled by architecture, involving technical ability, physical knowledge, social and cultural awareness, and artistic sensibility, does not quite contribute to giving the activity the clearness of instrumental procedure that is expected in the knowledge specialist world that we live in. While at the same time being ambiguous between the artistic irresponsibility and the strictness of scientific method, we should ask ourselves whether artists are irresponsible or scientists strict.

Presently, one of the reasons why architects are considered so, derives from the fact that architects draw (as in sketching), but they also draw scientifically (as in Gaspard Monge's descriptive geometry). Of course we could also say that what architects draw depends on facts and data with scientific validation, but then, the people who produced such data would be better suited to use it, knowing about it with greater ease, naturally knowing it. Which as we know is not quite true.

From the 'norm images' point of view, we are taken to ask ourselves: what kind of image are we thinking of? The retinal impression that is engraved at random, some acquired notion derived from geometry, something completely different, or is it a mix of the above?

Rudolph Arnheim (1969) gives us a correct notion of what is to be expected from sensorial input, in order to form valid concepts that may be used as knowledge (fig. 4).

Assessing the importance of sight, he distinguishes the retinal projection of an image, from the human perception acquired through this projection. Perception becomes analogous to an intellectual concept, and in some circumstances they end up as the same.

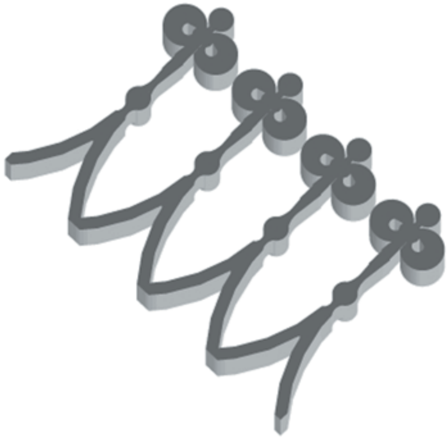

figure 4. Norm images have figural quality

A relevant fact in this process is the formation of a constant visual concept that one associates with a particular object, identified in order to deal with practical necessities of everyday life: for instance, a lettuce that needs to be put well under the attention, displaying its expected green color.

Visual concepts thus need some sort of constancy in order to be easily manipulated in our mind; at the same time, there is a changing degree of intelligence that creates a variation on how this constancy is formed. The way the constant image is created, taking or not into consideration the context where that object is perceived, creates this variation.

The conclusion (Arnheim, 1969) is that the possibility of observing an object in a changing context is bound to give us new information on what is constant about that object, and that is why scientists should always be in quest for new situations, capable of giving him new information. This is what should be associated with productive thought. On the other hand, if our constant image is frozen as a stereotype, we will never have its satisfactory sensorial verification taken from tangible experience; we will be blind to significant changes that may have occurred on the original concept, or

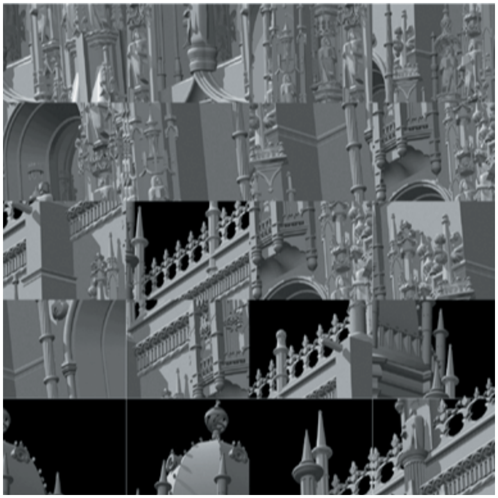

figure 5. Saccadic eye-movement.

revelation granted by new contexts.

The type of order which connects a perception subject to changes in context is described as an ordered sequence of a progressive change, where different points of view appear as a melting of different states of one single persistent object.

Another type of constance happens when different views appear as deviations or distortions of one simpler shape. Arnheim (1969) concludes by observing that these distortions not only allow but actively imply the discovery of the prototype, and, consequently, they are not perceived as a negative feature hiding the true shape of the invariant object, but positively, caused by a condition which exists over the true shape of the object, as logic consequence. As such, a tilted tree may be seen as a normal tree changed by the effect of winds.

Drawing as seeing as science

Gibson (1950), states that visual perception can be either schematic, i.e. originated from learning and prior convention about meaning, or literal. Realizing the convenience of sight for what he calls "getting about and doing things" he points out that there is something special taking place between what we perceive from seeing, and the flat physiological retinal picture: what he calls "the puzzle of the third dimension". He says that this is a problem about perceiving space, which means identifying shapes, distinguishing them from a background and realizing their relative location and position at which they lie.

Objective and literal vision is what concerns the architect when dealing with sight. This depends upon the mechanisms of perception, where literal visual input is dealt with from a flat light-dependant impression - the visual field - and at the same time realizing a three dimensional space where objects stand with constant shapes, the visual world. The theory about it is that we operate on correlates of objective properties, that become variables of perception, worked through the retinal projection, saccadic eye-movement (Gibson, 1950) (fig. 5), and movement of the observer in space.

There is thus a capacity in visual perception, to compose overlapping retinal projections into panoramic vision, where successive focus of sight are combined through primary memory-vision (fig. 6).

One of the utmost importance operations that take place is that we are able to create distinctions upon the impressions of the visual field. From all the changes that take place when we look at something, both staring or rapidly changing focus and shifting stands, we are able to perceive constancy from the changing impressions that concern one single object, and we are also able of discriminating between objects, detecting an entity that at some point is not an object but a background. This kind of operation allows us to identify objects, naming them and associating meaning to their names and to their visual impressions (fig. 7).

Taking the architect's stand about how we look, the objective is to seize the features of the literal visual world, to be able to look objectively and detect reality. There is meaning to be attached to his work, but at some point, he must be able not to let himself as a subject, interfere with this

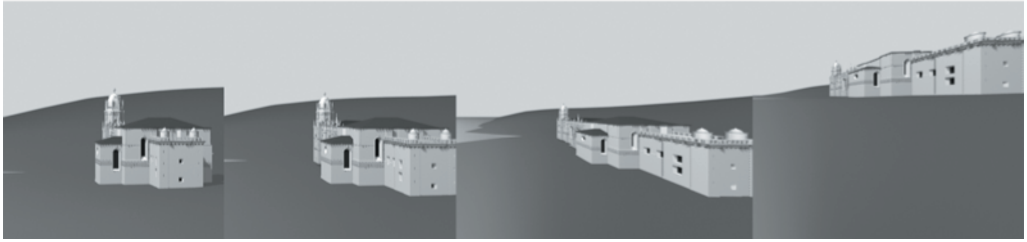

figure 6. Differences in the visual field and factors of projection.

figure 7. Differentiating constant shapes.

objective stand. It is not enough to take measures and descriptively draw, because he must be able to discriminate and identify, creating the objective correlates of those visual impressions.

A Spanish architect and teacher of architecture at the University of Navarra in Pamplona, named Ignacio Araujo (Araujo, 1976), made a synthesis on his academic writings, where he points out that an architect learns how to look when drawing. His drawing means to objectively take note of volumetric shapes and material textures, under the effect of light and color, by appropriate strokes of pen and pencil; strokes that must carry intent and correlate to reality. Modeling with the computer, one must carry this capacity of looking at, through drawing. There is increased distance from reality (fig 8) , but it should be none greater than being at a painter's studio looking at reality through another artist's work. Reality is then conceptualized with greater capacity to identify and discriminate.

Knowledge from drawing

There are factors in perception that should be taken into account, in connection to Guilford's (1967) distinction between the concrete and the abstract. These factors distinguish two kinds of mental images. One is associated with sensory stimulus and operating from a retinal projection, while the other is symbolic and builds upon the former existence of conventions that have to be previously learned (fig. 9).

We can easily associate the latter with symbols such as letter types being connected into words or mathematical expressions, but these conventions could also be other types of symbols, compared with Guilford's (1967) classification of "figural factor". They are symbols where space manipulation is associated with semantic content conveyed in written form, and Arnheim (1969) mentions them when talking about representation, symbols and signs. As such, these kinds of constructs, are different in nature from Guilford's concrete intelligence which is built upon perception. Although visual, they are different from the classification operated through perception that Arnheim associates with the images of thought, because these correspond to the "bone like structure of traits withdrawn from exterior visual stimulus, maintaining some degree of isomorphism with that stimulus".

Concreteness is a quality that should be emphasized. It is a term used by Piaget (1937) to explain what goes on at the early stages of a child's development, when he mentions the need to exercise sensory-motor manipulation, in order to acquire knowledge and adequate schemes of behavior, a process which is also determined by interacting with others or socializing. Arnheim (1969) calls upon the traditional distinction between the person who tends to work through symbolic manipulation and the one who operates manually on the con-

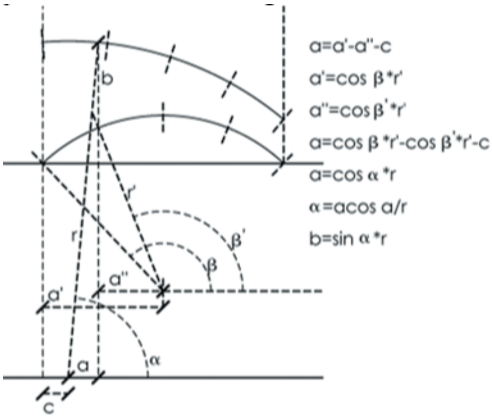

figure 8. Geometry and trigonometry.

figure 9. Symbolic meaning.

crete world. And he concludes that this is not an appropriate distinction, because the development and exercise of mental capacities is also associated with operations dealing with the physical manipulation of objects from the concrete world. He uses the expression: “oriented towards ideas or towards objects”.

Physical behavior is determined by perceptual ability, and every sort of manipulation involves an assessment about how appropriate one solution might be, how does it work, which is typical of a productive thought. Such manipulations take the form of physical behavior. Thus we can say that sensory-motor behavior implies manipulating abstract ideas.

The conclusion to be made (Arnheim, 1969) is that any object that looks articulate is going to give away perceptual clues that in turn build up the elaboration of thought. There is then a cause-effect relationship between the way a child’s environment looks and how physically manipulative he can be over that environment, and the build up of his cognitive abilities. The reason why this happens is because we operate with both analytic and synthetic judgment, and consequently, whenever we are actively thinking, even if using words, we are recalling previous perceptive experience.

Visual media becomes an advantage because it keeps structural equivalents with features taken from objects, events and relationships. Thinking of cognition as perception, it is both the fruit of intuition about the whole, where one becomes aware of the general organization of shapes, colors, place and function in relation to each other, and the intellectual analysis of the elements, operating through the listing of each and every one, and its particular properties.

We know that the world perceived through vision has depth, extends itself in distance, and that it is filled with meaningful objects. We have the conviction that these qualities can be observed through sight, and we tend to think that sight is the same as one image. Actually it is not. Through sight we acquire correlates of the world, which are perceived as an organized complex of variations. There are properties, both light dependent and of phenomenal type, that are correlated with patterns of variation, allowing us to establish constant and literal perception over reality. This variation and correlation integrates figural qualities (the norm image), patterns of change, projection, and discrepancies. Objects are discriminated and differentiated, identified, and detached from a background when constancy is perceived as a quality. This background in turn is made up of more objects. They establish a more complex perception organized through proximity, similarity, symmetry and good continuity, building on inclusive space (figs. 10 and 11).

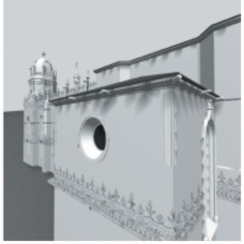

figure 10. Organizing principles.

figure 11. Organizing principles.

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