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AURAL DIFFERENCES OF ELEMENTARY ARCHITECTURAL CONFIGURATIONS: A COMPARATIVE TABLE.

Papageorgiou Ilias

National Technical University of Athens, Faculty of Architecture, Athens, Greece
email: hlipap@teemail.gr

The aim of the paper is to investigate the potential and differences among elementary spatial configurations. Examples of such configurations are a corner, a niche, a street, a curve and can be symbolized by simple alphabet letters or other symbols: L, Π, =,). The paper examines such configurations through the potential of two or more people to communicate: To approach, to see and hear each other with an emphasis on acoustic properties. All results are classified in a table which shows similarities and differences. The table could be useful to architects because it shows, in a laconic way, properties and data without the actual calculations or specialized knowledge behind them.

Keywords: Elementary spacial configurations, Table

1. Introduction

In the past years there has been an effort amongst architects to investigate the potential and differences of elementary spatial configurations. Francis Ching's book, Architecture, Form, Space and Order [1] is the most known publication. This effort can be also observed in everyday architectural practice, where architects, while designing, try to indicate with sketches differences among the shapes of space. Examples of such configurations are a corner, a niche, a street, a curve and can be symbolized with simple alphabet letters or other symbols: L, Π, =,). The differences are usually perceived intuitively. The lessons of Tassos Biris in the National Technical School of Athens are indicative of such a way of thinking [2]. In some cases one can notice a consistent and continuous effort to relate the potential of space to a systematic way of understanding. Herman Hertzberger's *Lessons for students in architecture* [3] explores the relation between spatial configuration and social issues and Jan Gehl's *Life between buildings* [4] relates the same issues to the human senses.

This paper follows the same tradition and tries to add to the existing knowledge a more exact notion of public and private based on the combination and comparison of all senses. It examines spatial configurations through the potential of two or more people to communicate: The object of research is the study of social distances, as they are perceived by the senses, i.e. how one man can hear, see and approach another person in different areas in space. More specifically, the discussion encompasses the distance between at least two persons, as defined by their potential for communication or privacy. Three distinct but overlapping fields are analysed: the visual, auditory and kinetic.

Although senses are equally important, the paper concentrates on the acoustic properties of space. Visual and kinetic properties are presented in a condensed manner and mainly in comparison to the aural ones. Through this comparison one can note similarities and differences in the way the senses work.

Spatial formations are studied with the help of sound propagation software, namely Olive Tree Lab, by modelling such configurations with variations concerning the angle and scale of their basic

elements. Materials and height of all elements are always the same: A rather reflective material is attributed to the walls (Indicative absorption coefficient: 250 Hz: 0.01; 500 Hz : 0.011; 1000Hz: 0,018) which are always 4m height. On the contrary, the configurations stand on an absorbing ground (250 Hz: 0,47; 500 Hz: 0,64; 1000Hz: 0,79). In this way only the effect of the configuration is depicted on the mappings. A constant source, a human voice of 67 dB(A), is placed in several locations inside these configurations, and then mappings of Sound Pressure Level are created. These mappings indicate properties on issues such as direction of sound and reveal intangible limits, namely thresholds, along which the aural properties of specific areas inside the configuration change drastically.

2. Comparison of spatial formations

Specific types of spatial formations are studied and categorized according to the fields of potential interaction created inside them: the void, the plane, the combination of planes and the curve.

2.1 Void

Through the description of the mechanisms of perception, it is proven that perceptual distances do not equal real distances. Both sound and perspective image are well perceived in the first meters but then decrease abruptly, while further away the decrease is less noticeable. Figures 1 and 2 showcase the similarities between the two senses. The distance between two persons, the void, is an important factor for their coexistence.

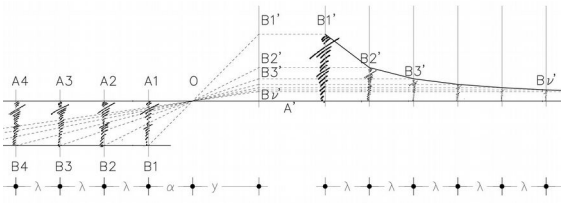

Figure 1 : Attenuation of the perspective projection of a man.

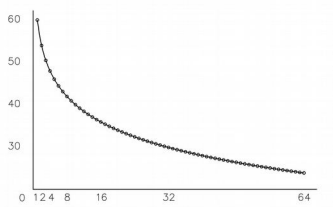

Figure 2 : Decrease of Sound Pressure Level (SPL) of a source. Aural and visual decrease is similar.

2.2 Plane

Space is even less homogeneous when architectural elements come into play. A single wall changes human distances: By dividing space into two semi-planes it restricts potential movements of others towards someone standing close to it and shields one's back from view, thus providing privacy and protection. Through reflections, though, it propagates sound further in a direction both perpendicular and parallel to the wall. A human voice is better perceived when someone stands next to a wall and this makes place less private for him.

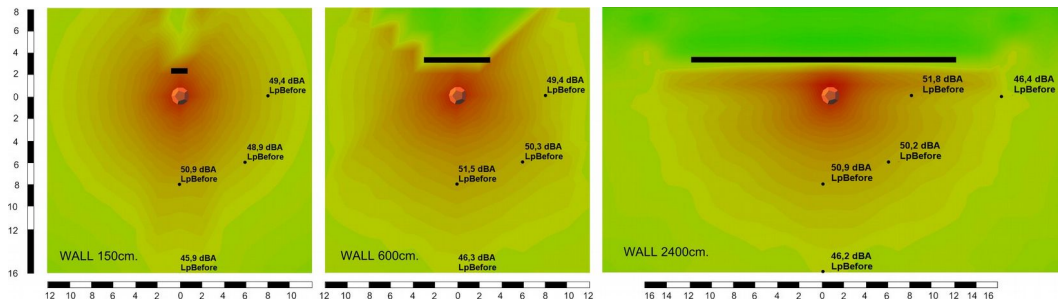

Figure 3 : SPL mappings of a 150cm, a 600 cm and a 2400cm wall.

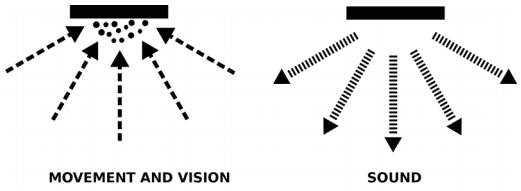

Figure 4 : Notion of privacy concerning movement and vision compared to sound.

2.3 Combination of planes

Combination of planes increases the degree of enclosure of an area. A corner is even more autonomous, since the potential movements to any other point in space do not pass from the area close to the section of the walls. The potential of being seen sideways decreases and peripheral vision is restricted. The sound pressure level, though, is amplified, since the reflections return to the source.

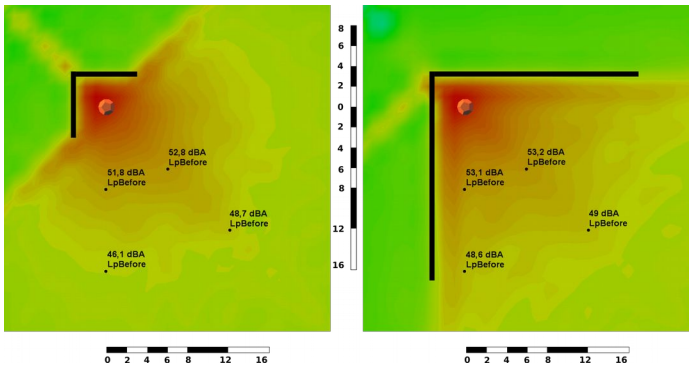

Figure 5 : SPL mappings of a 4m and a 20m corner.

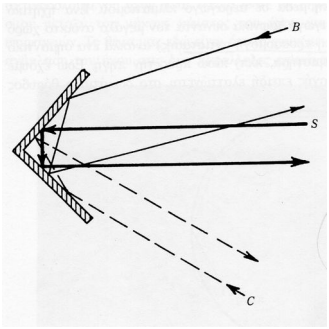

Figure 6 : Second reflections in a right angle [5].

Acute and obtuse angles present interesting qualities. An obtuse angle diffuses sound through first and second reflections, while an acute angle can work as a very good receiver because the sound energy is maintained within it, through multiple reflections. Someone that sits in an acute corner is not easily seen by the others, but can hear them very well.

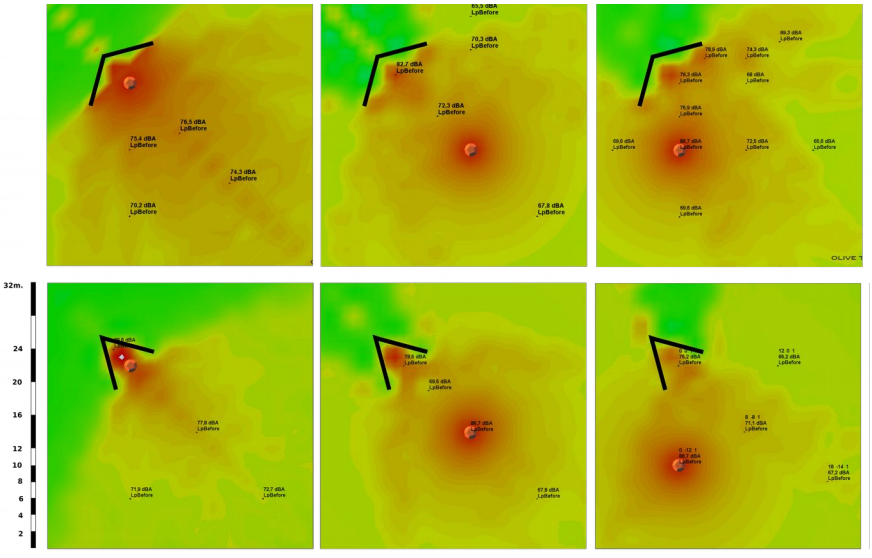

Figure 7 : SPL mappings of acute and obtuse angles, when the source is inside and outside the configuration

Two parallel planes form a street. The street is the place where public and private meet constantly. The potential of quick glances increases and people standing coexist with people walking. In a street the visual, kinetic and aural notions of private and public coincide. Concerning the acoustic properties, side reflections propagate sound along its main axis, thus unifying its area.

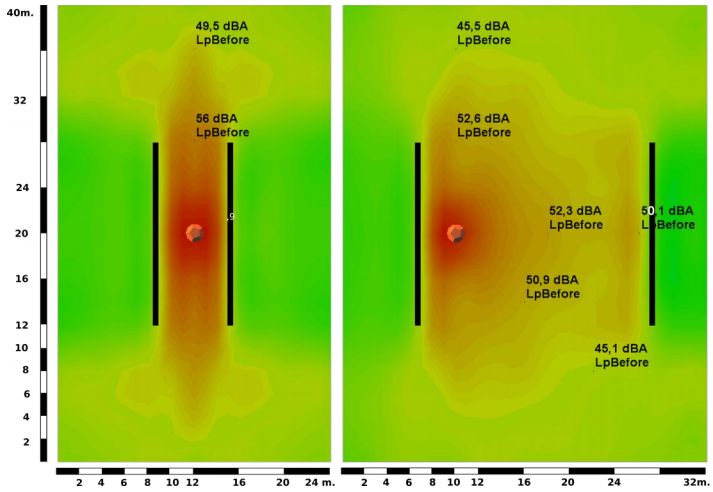

Figure 8 : SPL mappings on a narrow and a wide street.

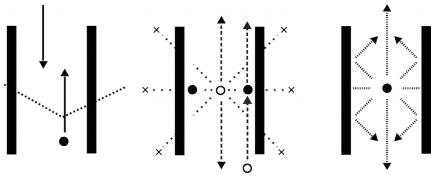

Figure 9 : Visual, kinetic and oral fields of potential interaction between two persons in a street.

2.4. Bending planes (curves)

Curves also enclose space. They bring people closer and unite them visually. They don't create, though, private space the way a corner does. Privacy varies greatly depending on size and convexity. When it comes to acoustics, a curve focuses sound in certain points or areas and propagates it, through tangent reflections, along its perimeter. In other areas, though, reflections are poor. The receiver only receives one reflection. The sense of acoustic quality in curved forms is based on the few focusing points or areas, but in general their potential is overrated.

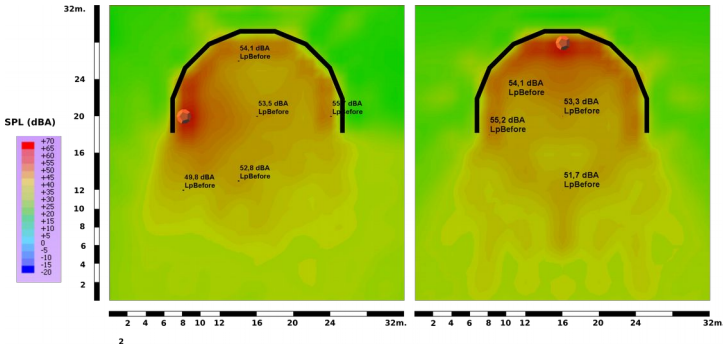

Figure 10 : SPL mappings on a curve. The tangent propagation is noticeable.

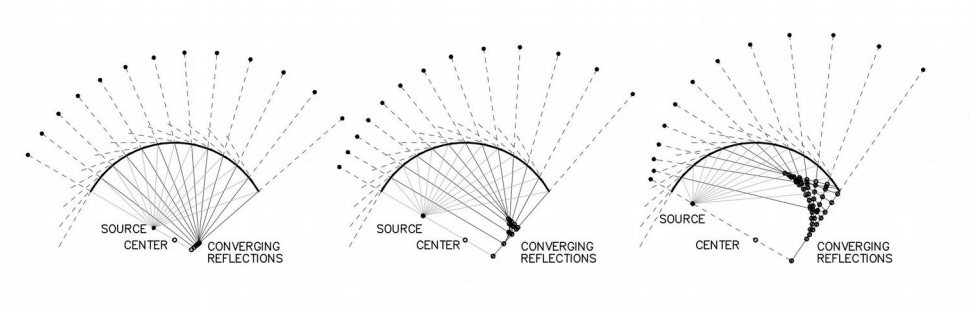

Figure 11 : Focusing phenomena in an open curve. In many areas inside a curve the receiver receives only one reflection.

3. A comparative table

A comparison of the properties of spatial formations reveals significant differences between spatial configurations. The notion of private and public, the perceived distance between two persons, is not always and everywhere the same. All results are classified in a table. The configurations are listed on the vertical access, while the senses are listed on the horizontal one. Small comments under each configuration give information about the specific form.

It must be noted that the typology does not follow Kandinsky's 'point-line-plane' sequence [6], as many approaches do [1]. The painting elements do not correspond to architectural elements, since a point in a plan indicates a line and a line indicates a plane. Here a different typology is proposed, which gives emphasis not to the volumetric appearance of buildings as objects but more to the in-between [3]. The typology starts from the 'void'. The first perceivable element of space is the 'plane'. Combinations of planes and curves can describe many real examples of our environment.

The configurations of the table are standardised as 'Ideal Types'. An Ideal Type (Idealtypus in German) is a term that sociologist Max Weber uses in order to describe human mental creations that can sort and explain real phenomena which although complicated, present similarities. They are not proposed as archetypes that need to be followed but rather as abstractions that can help our understanding of space.

This table could be useful to architects because it shows, in a laconic way, properties and data without the actual calculations or specialized knowledge behind them. The information of the table can be used in architectural composition when such or similar configurations are designed.

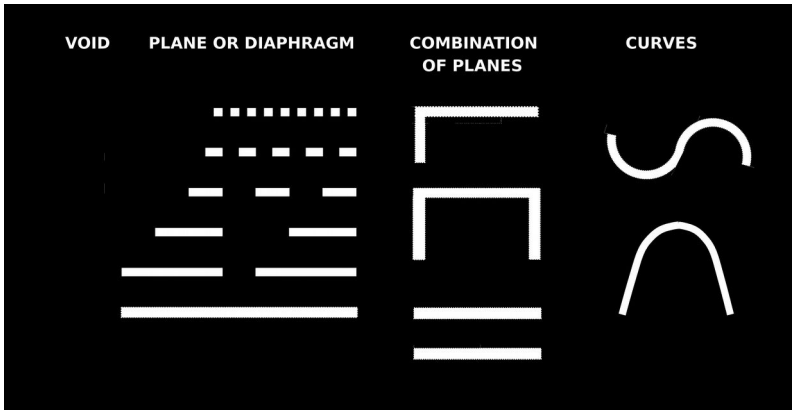

Figure 12 : Proposed typology of spatial configurations.

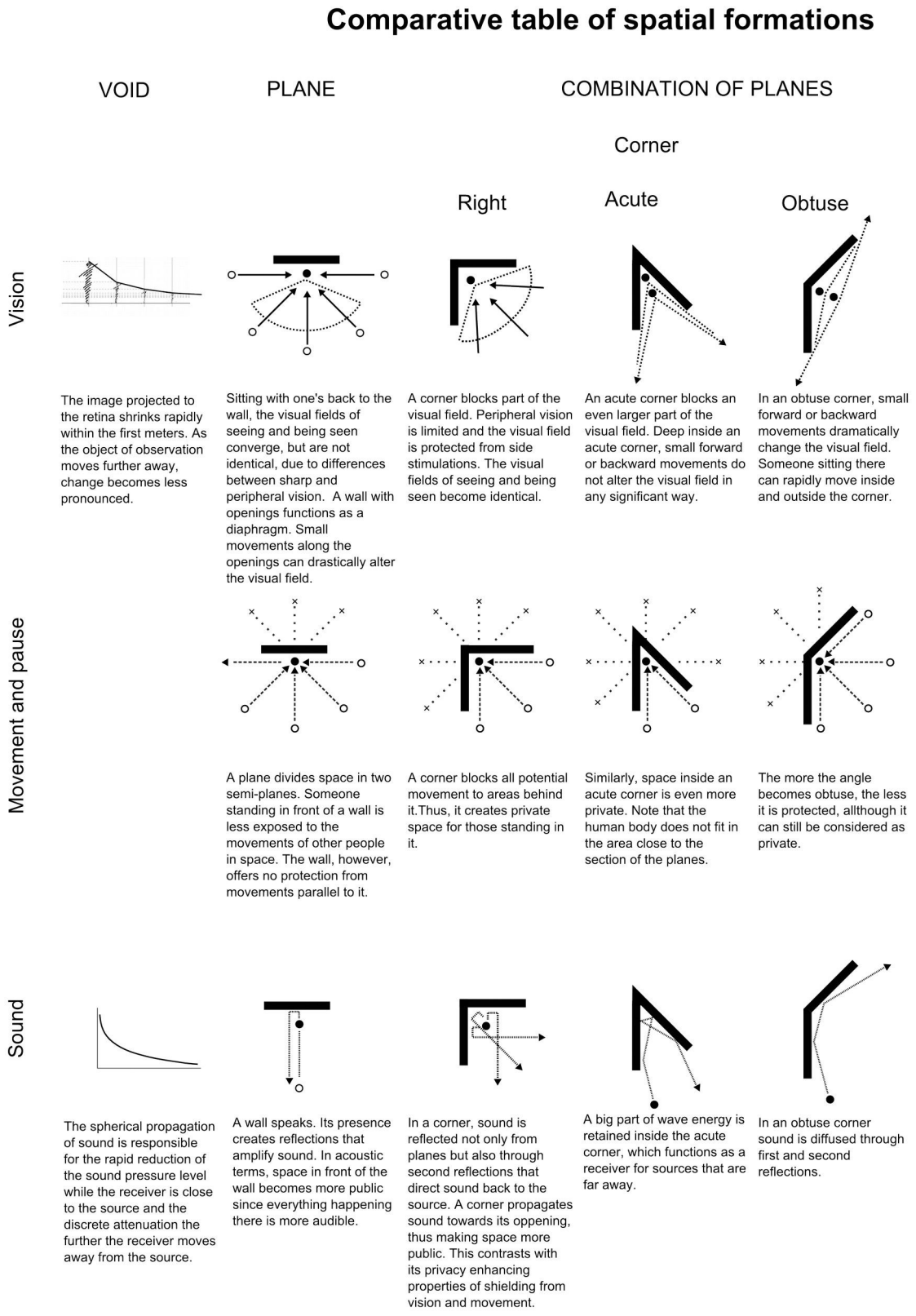

Figure 13 : A detailed table of all spatial configurations (part 1). Horizontaly lie the different senses (vision, movement and sound). The configurations are listed vertically.

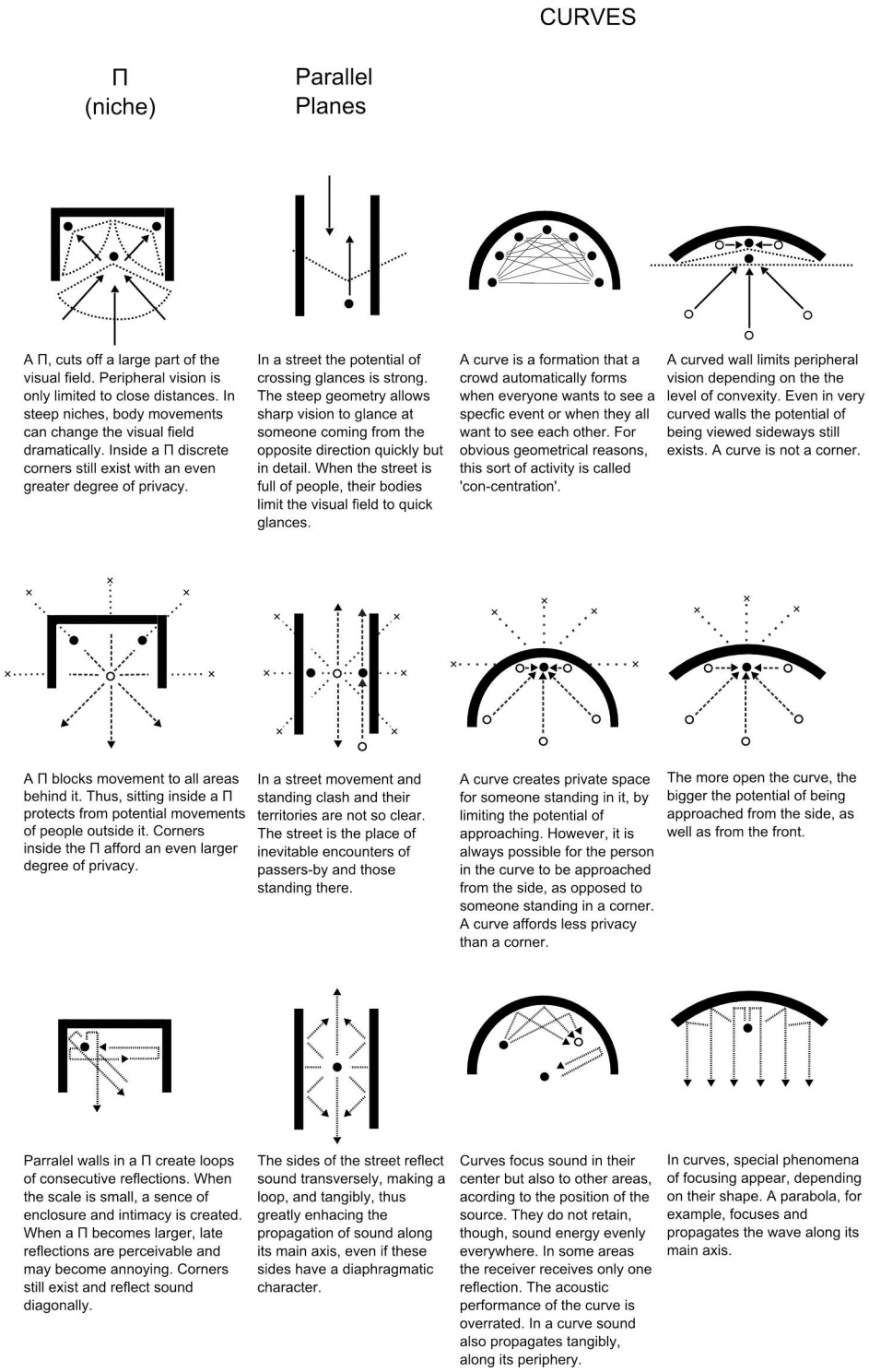

Figure 14 : A detailed table of all spatial configurations (part 2). Horizontaly lie the different senses (vision, movement and sound). The configurations are listed vertically.

REFERENCES

1 Ching, F. D. K, *Architecture, form, space and order,* John Wiley & Sons, Hoboken, NJ (2007).

2 Biris, T, *Architecture's signs and teachings, The trace of synthetic structure,* (in greek), MIET, Athens, GR (1996)

3 Hertzberger, H, *Lessons for students in architecture,* 010 Publishers, Rotterdam, NL (1993)

4 Gehl, J, *Life between buildings, Using public space,* Architektens Forlag, Bogrrykkeriet, DK (1996)

5 Everest, A. F, *The master handbook of acoustics* (in greek), Tziolas, Salonica, GR (2003)

6 Kandinski, V, *Point, line, plane, A contribution to the analysis of painting elements*, (in greek), Dodoni, Athens, GR (2013)