

AURAL DIFFERENCES OF ELEMENTARY ARCHITECTURAL CONFIGURATIONS: A COMPARATIVE TABLE.

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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 show-case the similarities between the two senses. The distance between two persons, the void, is an important factor for their coexistence.

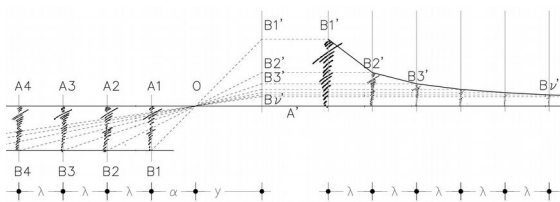


Figure 1 : Attenuation of the perspective projection of a man.

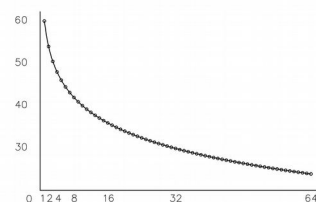


Figure 2 : Decrease of Sound Pressure Level (SPL) of a source. Aural and visual decrease is similar.

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.

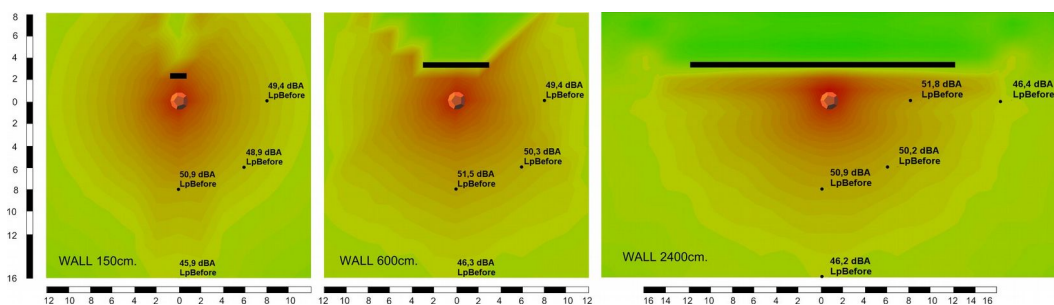


Figure 3 : SPL mappings of a 150cm, a 600 cm and a 2400cm wall.

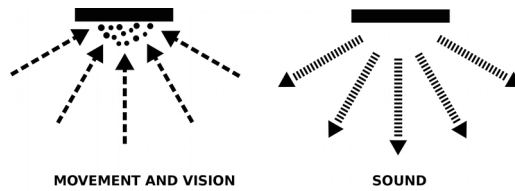


Figure 4 : Notion of privacy concerning movement and vision compared to sound.

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.

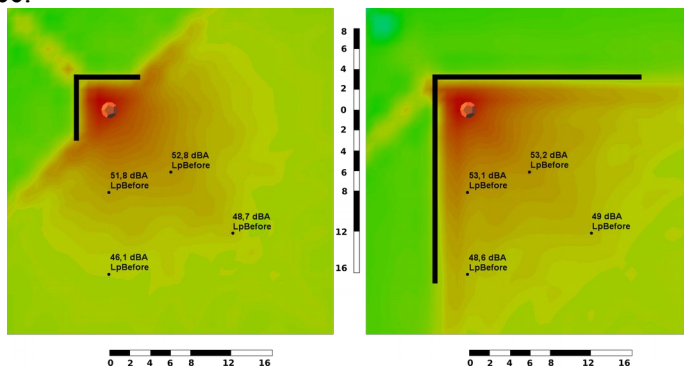


Figure 5 : SPL mappings of a 4m and a 20m corner.

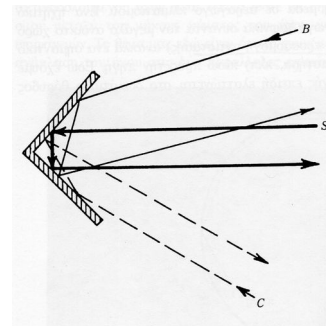


Figure 6 : Second reflections in a right angle [5].

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.

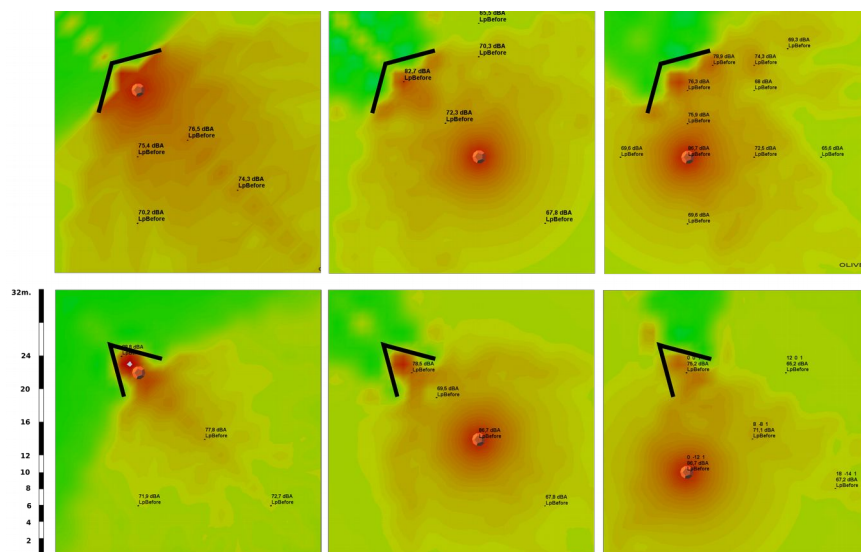


Figure 7 : SPL mappings of acute and obtuse angles, when the source is inside and outside the configuration

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.

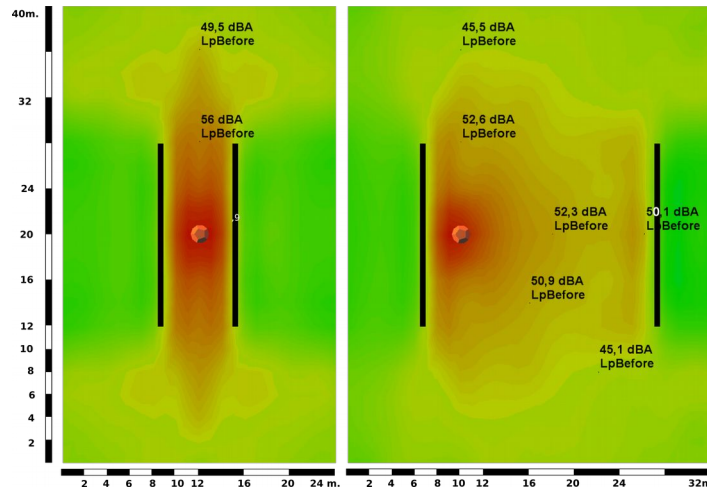


Figure 8 : SPL mappings on a narrow and a wide street.

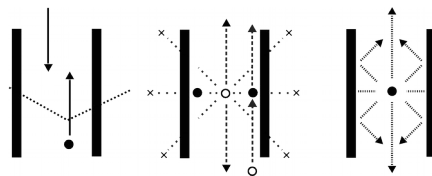


Figure 9 : Visual, kinetic and oral fields of potential interaction between two persons in a street.

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.

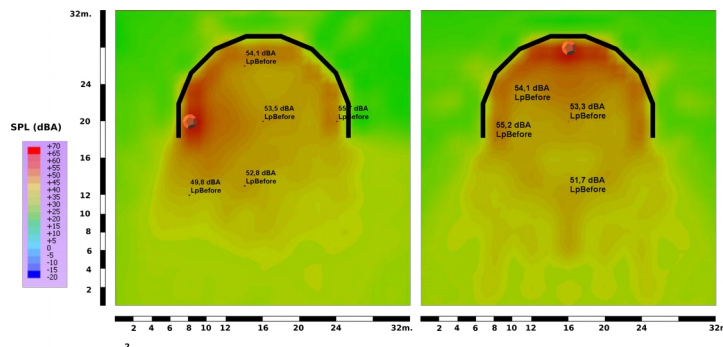


Figure 10 : SPL mappings on a curve. The tangent propagation is noticeable.

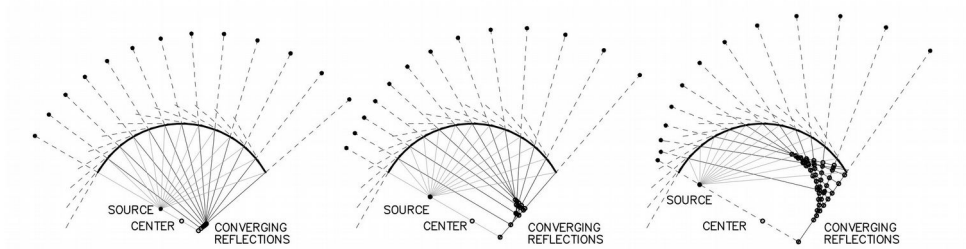


Figure 11 : Focusing phenomena in an open curve. In many areas inside a curve the receiver receives only one reflection.

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.

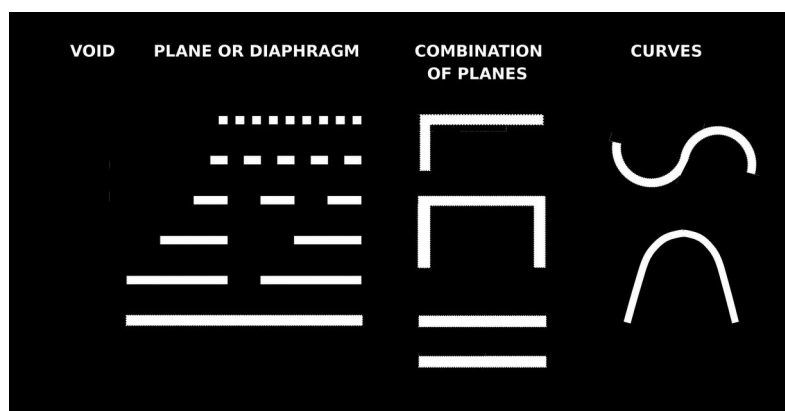


Figure 12 : Proposed typology of spatial configurations.

Comparative table of spatial formations

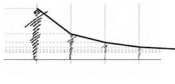
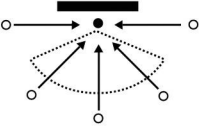
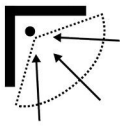
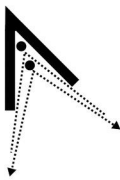
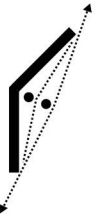
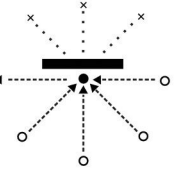
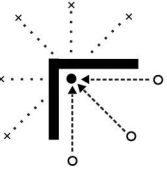
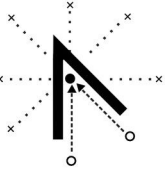
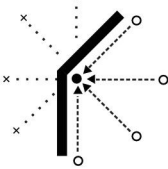
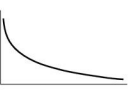



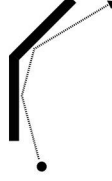
	VOID	PLANE	COMBINATION OF PLANES		
			Corner		
			Right	Acute	Obtuse
Vision	 <p>The image projected to the retina shrinks rapidly within the first meters. As the object of observation moves further away, change becomes less pronounced.</p>	 <p>Sitting with one's back to the wall, the visual fields of seeing and being seen converge, but are not identical, due to differences between sharp and peripheral vision. A wall with openings functions as a diaphragm. Small movements along the openings can drastically alter the visual field.</p>	 <p>A corner blocks part of the visual field. Peripheral vision is limited and the visual field is protected from side stimulations. The visual fields of seeing and being seen become identical.</p>	 <p>An acute corner blocks an even larger part of the visual field. Deep inside an acute corner, small forward or backward movements do not alter the visual field in any significant way.</p>	 <p>In an obtuse corner, small forward or backward movements dramatically change the visual field. Someone sitting there can rapidly move inside and outside the corner.</p>
Movement and pause		 <p>A plane divides space in two semi-planes. Someone standing in front of a wall is less exposed to the movements of other people in space. The wall, however, offers no protection from movements parallel to it.</p>	 <p>A corner blocks all potential movement to areas behind it. Thus, it creates private space for those standing in it.</p>	 <p>Similarly, space inside an acute corner is even more private. Note that the human body does not fit in the area close to the section of the planes.</p>	 <p>The more the angle becomes obtuse, the less it is protected, although it can still be considered as private.</p>
Sound	 <p>The spherical propagation of sound is responsible for the rapid reduction of the sound pressure level while the receiver is close to the source and the discrete attenuation the further the receiver moves away from the source.</p>	 <p>A wall speaks. Its presence creates reflections that amplify sound. In acoustic terms, space in front of the wall becomes more public since everything happening there is more audible.</p>	 <p>In a corner, sound is reflected not only from planes but also through second reflections that direct sound back to the source. A corner propagates sound towards its opening, thus making space more public. This contrasts with its privacy enhancing properties of shielding from vision and movement.</p>	 <p>A big part of wave energy is retained inside the acute corner, which functions as a receiver for sources that are far away.</p>	 <p>In an obtuse corner sound is diffused through first and second reflections.</p>

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

CURVES

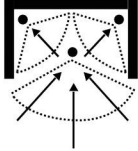
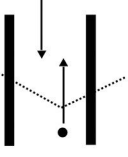

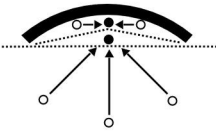
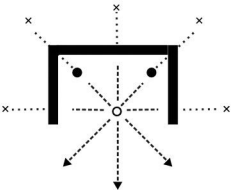
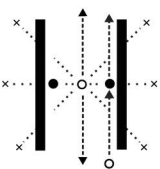
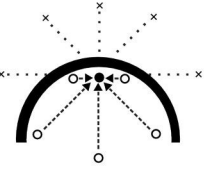
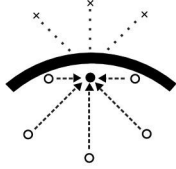

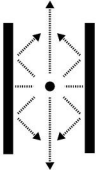

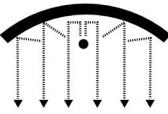
Π (niche)	Parallel Planes		
			
A Π, cuts off a large part of the visual field. Peripheral vision is only limited to close distances. In steep niches, body movements can change the visual field dramatically. Inside a Π discrete corners still exist with an even greater degree of privacy.	In a street the potential of crossing glances is strong. The steep geometry allows sharp vision to glance at someone coming from the opposite direction quickly but in detail. When the street is full of people, their bodies limit the visual field to quick glances.	A curve is a formation that a crowd automatically forms when everyone wants to see a specific event or when they all want to see each other. For obvious geometrical reasons, this sort of activity is called 'con-centration'.	A curved wall limits peripheral vision depending on the the level of convexity. Even in very curved walls the potential of being viewed sideways still exists. A curve is not a corner.
			
A Π blocks movement to all areas behind it. Thus, sitting inside a Π protects from potential movements of people outside it. Corners inside the Π afford an even larger degree of privacy.	In a street movement and standing clash and their territories are not so clear. The street is the place of inevitable encounters of passers-by and those standing there.	A curve creates private space for someone standing in it, by limiting the potential of approaching. However, it is always possible for the person in the curve to be approached from the side, as opposed to someone standing in a corner. A curve affords less privacy than a corner.	The more open the curve, the bigger the potential of being approached from the side, as well as from the front.
			
Parallel walls in a Π create loops of consecutive reflections. When the scale is small, a sense of enclosure and intimacy is created. When a Π becomes larger, late reflections are perceivable and may become annoying. Corners still exist and reflect sound diagonally.	The sides of the street reflect sound transversely, making a loop, and tangibly, thus greatly enhancing the propagation of sound along its main axis, even if these sides have a diaphragmatic character.	Curves focus sound in their center but also to other areas, according to the position of the source. They do not retain, though, sound energy evenly everywhere. In some areas the receiver receives only one reflection. The acoustic performance of the curve is overrated. In a curve sound also propagates tangibly, along its periphery.	In curves, special phenomena of focusing appear, depending on their shape. A parabola, for example, focuses and propagates the wave along its main axis.

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

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