SURVEY AND CO-DESIGN THE URBAN LANDSCAPE. INNOVATIVE DIGITAL PATH FOR PERCEPTION ANALYSIS AND DATA-DRIVEN PROJECT

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ABSTRACT

The research presents the participatory processes implemented using Eye-track and EEG to analyse and "survey" the landscape, the immaterial relation that determines the quality of places. If it is always feasible to measure quantities, it is more complex to bring out data and interpretations on the values of places. This path based on the centrality of vision, it focuses on the possibility of detecting through biosensors what attracts the eye most, but also on the effect of vision of this on man. By combining these instruments and their data, it is possible to associate the observer's staring with the sensations he feels, thus explicitly explaining the concept of imageability expressed by Kevin Lynch, it is possible to individuate precisely which elements of the urban space attract the observer and what kind of status arouse in him.

Figure 1 – Representing perception: mesh with the value attribute calculated through the circumplex model.

1. INTRODUCTION

Every day more, landscape question becomes one of the themes more debated in academic and political contexts. Everyone wants to preserve landscape but it is not clear what the real subject of their interest is.

The European Landscape Convention defines: "landscape means an area, as perceived by people, whose character is the result of the interaction of natural and/or human factors ...the expression of the diversity of their shared cultural and natural heritage, and a foundation of their identity ". The idea of landscape closely linked to perception, to vision and to those elements that structure the processes of identity construction.

It is possible to extend Kant’s philosophic considerations reported in his “Critique of Judgment” (1790), where he asserts that landscape shall not be simply judged as beautiful nor sublime, but rather more perceived as a state of mind. It is possible to "distinguish two styles of perception: one is pragmatic

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and action-oriented, the other is aesthetic and affect-oriented"... in a "cognitive-semiotic theory of conceptual organization and semantic integration in general”.... "both the meaning structures found in art and the surplus meanings of things, their ‘connotations’ are based on non-integrated structures that tend to be integrated on higher levels of mental architecture. The emphatic splitting of experienced situational meaning into two mutually mapping mental spaces—a content space and an expression space—which is characteristic of the phenomenology of works of art and other aesthetically perceived objects, is due to this phenomenon of unintegrated surplus structures" (Brandt, 2006).

In this regard it is possible to understand how the theme, especially if declined in the European city, rich in stratifications and signs, opens to reflect on how the community who lives them can really understand their value, but also creatively participate in protecting and enhance them (Norberg-Schulz, 1992), exploiting also the capabilities of the new digital tools.

The research presents the participatory processes implemented using Eye-track and EEG to analyse and "detect" the landscape, the immaterial relation that determines the quality of places. Such means, up to a recent past, were the prerogative of medical disciplines because of their cost and of the lack of portability. Today they work for marketing purposes, while their use is innovative to understand the public space and as tools for co-designing.

The research tackles the challenge of quality survey (Bianconi and Filippucci, 2018a): if it is always feasible to measure quantities, it is more complex to bring out data and interpretations on the values of places. This path is based on the centrality of vision (Kepes and Chiaia, 1990), the possibility of detecting through biosensors what attracts the eye most, but also the effect of vision of this on man. By combining biosensors, it is possible to associate the observer's staring with the sensations he feels, thus explicitly explaining the concept of imageability expressed by Kevin Lynch (Lynch, 1960), it is possible to individuate precisely which elements of the urban space attract the observer and what kind of status arouse in him.

Through this methodology with a statistical sample, it is possible to identify on average which elements people perceive and which sensations they cause in them. In this way, it is possible to pursue an analysis aimed at a heuristic research for higher quality, with people who simultaneously acquire awareness of the value of their goods (Settis, 2014).

It is therefore possible to set up a co-planning of urban spaces, focused on meanings and not on signs, a specific competence of designers that will not be delegated to a sort of popular jury. The path, however, wants to identify empirically but with a scientific basis and a concrete analyticity in order to intervene effectively, which are the critical issues of the environments and which are the elements of greatest interest to valorise. From the analysis of the results, in fact, it is possible to individuate urban space detractors and the use and placement of urban furnishings, those that generate a negative emotional state. The path can become a paradigmatic example of wayfinding (Belardi and Bianconi, 2012), supported by digital instruments (Bianconi et al., 2019), in a participatory approach in the co-design of public spaces (Bianconi and Filippucci, 2017a). It is about educating the vision (Arnheim, 1986), redefining the centrality of the attention, which is the base of the care of places, but also the definition of the role of the community in protecting and enhancing the cultural heritage.

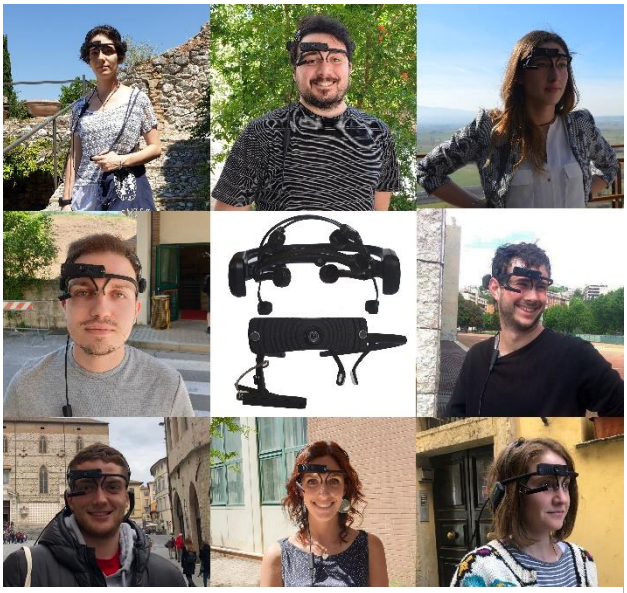

Figure 2 – Survey campaigns and testers with EEG, Eye-tracker and GPS.

2. MAIN BODY

2.1 The research themes

The research project aims to innovate the approach to the design of urban landscape and public spaces, finalized to increase human health and wellbeing in an intersection of solutions inherent social, cultural, digital and nature-based innovations.

In the centrality of human factor (Sanders and McCormick, 1987), new instruments and methodologies will be developed to examine a real environment, to value the future transformations, to identify and maximize the effects of the environment for man’s psychophysical well-being and to valorise the impact of interventions.

Through an interdisciplinary approach and by using new digital tools, the research promotes a redrawing of urban spaces from a perceptive point of view in relation with welfare, in order to analyse strategies for the mitigation of social exclusion and marginalization. Because space shapes our life (Sarah Williams Goldhagen, 2017). It could have a good or a negative effect, but it cannot be neutral and sometimes it contributes to psychophysical illnesses. The design of these public spaces too often is not directly addressed to citizen health (Millennium Ecosystem Assessment, 2005) and well-being (Bechtel and Churchman, 2002), also because there is no methodology to analyse and evaluate the effects of the solutions, a central data to promote a sustainable and welfare design and a participated development of the place.

In the last 20 years the research on health determinant factors clearly shifted the attention to the social dimension of the individual’s life (Badland and Pearce, 2019; Byrne et al., 2014; Carmichael, 2019; Corburn, 2004; House et al., 2007; Jackson L, 2003; Konstantinos Tzoulasa et al., 2007; Lee AC. Maheswaran R. and Lee A.C.K., 2011; Leeuw, 1999; M.C. et al., 2018; Schram-Bijkerk et al., 2018). Regarding the overall objective, the proposal wants to test new design strategies, new instruments and methodologies to examine a real environment, to value its future transformations, to identify and maximize the effects of the environment for man’s psychophysical well-being.

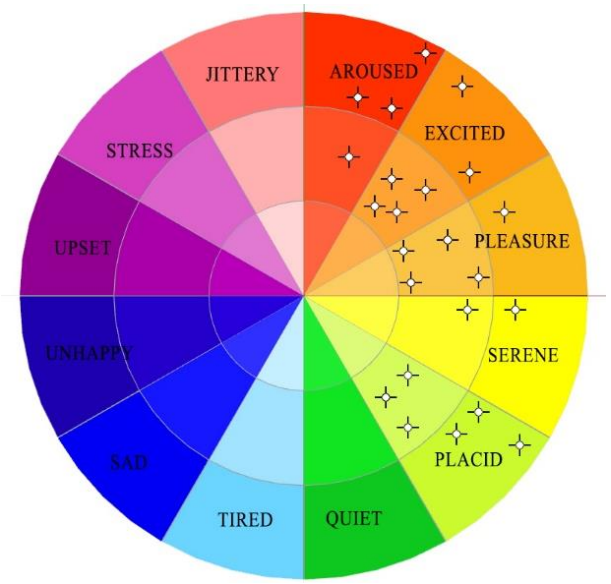

Figure 3 -The circumplex model 12-PAC with a tripartite division according to the intensity of the emotion, at the center the neutral value and the arrangement of some points related to a survey as a function of the two cognitive states.

In this way, the study defines a methodology to analyse public places impacts, in a multidisciplinary way, in health and well-being, surveying physical aspects of the city and the citizen behaviour of spaces.

Contemporary cities are conditioned by the modern movement, which pursuing an ideal of aesthetics due solely to functionalism, it made anonymous cities (Appadurai, 1996). Very similar buildings cannot create a figurability (Schultz, 1987), i.e. the quality that gives a physical object a high probability of evoking a vigorous image in every observer.

This contemporary image of the city (Fabio. Bianconi and Filippucci, 2019) underlines rather the relation of modernization which is typical of a widespread urban landscape, and which becomes ever more complex until it reaches its maximum level in the Nineteenth century, due to the conflicts inherent in its development (Appadurai, 1996). Within the city itself, in the wake of the victory of a business-oriented mentality, the built-up environment has undergone a change resulting in the multiplication of signals (Venturi et al., 1977) that imposes a multiplicity of space-time attractors (Appleyard et al., 1966) in a dynamic equilibria (Arnheim, 1965) that changes the face of the city. Urban landscape (Cullen, 1961) born in the reading activity, in the process of transforming the perceived data into patterns and meanings (Jencks, 1969). Representation becomes a transposition of sensible elements in intellectual synthesis, “it is never a given space but a built space” (Panofsky, 1927), where from every point of the space, equal constructions are possible to be built. Identify cannot be separated from identifying: recognisability allows the creation of a urban geography (Larkham and Short, 2006) and a psychogeography (Coverley, 2018) to emerge where the value of the sign (Debord, 1958), central in both perception and in the subsequent design phase, which is substance of connections between semiology and urban plan (Barthes, 1967) .

In this context, the public spaces represent a central paradigm of the historic urban landscape, as places intended to condense meanings. In particular, the public space (Francis et al., 2012; Gehl, 2007; Gehl and Gemzøe, 2003; Gehl and Svarre, 2013; Goheen, 1998) intended as a place where people of social groups, various cultural and demographic, meet and enter into different relations, a space where the public life is centred on communication (Castells, 2008) and vision (Friedman, 1972). The parameters (Ewing et al., 2013) that define spaces are the legibility, the easy interpretation of the surrounding environment (Lynch, 1984), the mystery, the opportunity to obtain additional information through the exploration (Debord, 2006), the intimacy and refuge, the ease of finding a shelter (Pallasmaa, 1994).

A different attention to the design can change the sense of the place for all (Norberg Schulz, 1979), but also the attention to the signposting and architectonic solutions of urban wayfinding (Bechtel and Churchman, 2002; Bianconi et al., 2019; Meng and Zhang, 2012). The idea of public space, in the ordinary usage is completely changed compared to the past, it is the identification of space and meeting that breaks the outskirts of the “analogue city” theorized by Aldo Rossi (Rossi et al., 1976). For many psychologists, the attractiveness of a public space is commensurate with its ability to see others as well as to be seen and to freely express themselves (Gehl, 2011). The public space holds the image of the city (Torelli, 1997) and it wants to focus on those aspects related to the memory of the visitors and of the consciousness of citizens , who are the keepers of their community’s values (Szondi and Mendelsohn, 1978).

The issue inheres the measure of perception. “Man is mainly a visual animal, and more than the 50% of his brain neurons respond to this sensorial incoming” (Maffei, 2007). Immaterial data are the real theme of virtual modeling, those elements that explain and describe in a different way what is observed (Bianconi and Filippucci, 2017b; Filippucci et al., 2016). The visualization of the intangible data allows to fully understanding the environment or the observed object (Bianconi et al., 2019; Gaulon et al., 2017; Remondino et al., 2009). The widely discussed theme of perception (Ancona, 1970; Arnheim, 1965, 1986; Bianconi and Filippucci, 2018b; Fabio Bianconi and Filippucci, 2019; Filippucci, 2013; Gibson, 2014; Gogel and Tietz, 1977; Gregory, 1998; Ramachandran, 1990) thus finds a new life in the field of neuroscience (Pinotti and Lucignani, 2007), which are linked to the logics of neuro-marketing (Berčík et al., 2016; Giraldi et al., 2017; Jordao et al., 2017; Lahmiri, 2018; Oliveira, 2014; Oliveira et al., 2014; Oliviera and Giraldi, 2017; Onay, 2016; Sloan, 2015) used also for urban landscape and public space.

Data are the petroleum of the future, but their real value emerges when they offer an interpretation of the reality, to understand the future transformation. As the MIT professor Alex Pentland affirms, “*Moving to a data-driven society will be a challenge. In a world of unlimited data, even the scientific method as we typically use it no longer works: there are so many potential connections that our standard statistical tools often generate nonsense results. The standard scientific approach gives us good results when the hypothesis is clear and the data are designed to answer the question. But in the messy complexity of large-scale social systems, there are often thousands of reasonable hypotheses; it is impossible to tune the data to all of them at once. Therefore, in this new era, we will need to manage our society in a new way. We have to begin testing connections in the real world far earlier and more frequently than we ever have before. We need to construct "living labs" in which we can test our ideas for building data-driven societies*” (Pentland, 2013) .

The study of human brain responses to sensations and stimuli stands as fundamental to select data as a function of their impact. It is a "cognitive heuristic" based on simple, rapid, but very effective schemes for evaluating transformation processes of data in information and the information itself in partial knowledge , to address complex situations through simpler problems (Marewski et al., 2010).

It is significant to note how the user becomes the leading actor, transcribed in the myth of the "consumer-actor" (Codeluppi, 2011), in the creation and dissemination of data, producing an enormous amount of information that becomes significant of trends and developments. If objects are smart and able to communicate, even the individual, in his activities, assumes the paradox of being subject and object of interest, the one who produces data that allows him to describe it, fundamental for marketing. The interest in this production of information is increasingly leading to move from the Internet of Things to the Internet of People (Berrocal et al., 2015; Conti et al., 2017, 2012; Florido et al., 2018; Rajah and Lim, 2018). It is a consequential condition for a greater convergence between the virtual world and the physical environment (Conti et al., 2012), where the digital does not lead to dreamlike engulfment of machines on man, but vice versa is directed more and more to put the person at the center (Anderson, 2002; Anderson et al., 2006; Buchanan, 2002; Cakir, 2011; Srivastava et al., 2012).

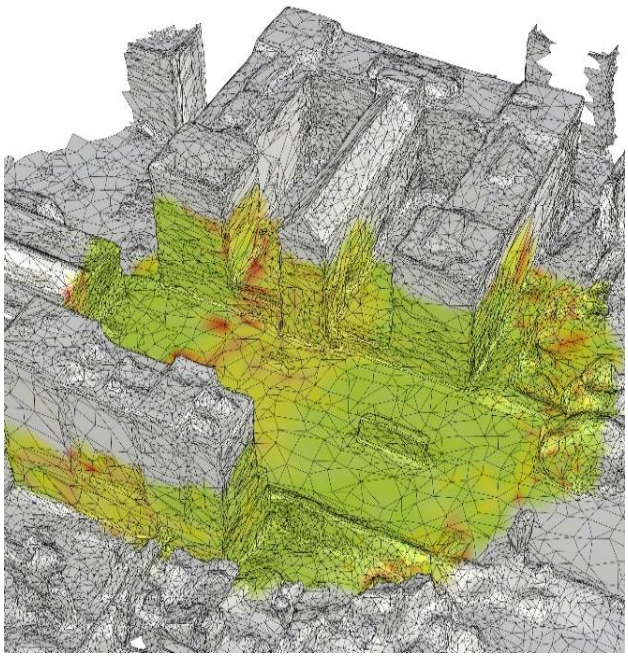

Figure 4 - The mesh built from the photo-modeling of Google Earth images with the RGB attribute.

2.2 Means and Methods

The innovative aspects that characterize the research are identifiable in the developed digital path. The relation between the psychology of vision and the representation, the analysis of the citizen behaviour in the public space, is develop using advanced digital tools and biosensors such as eye-tracking. This allows analysing analytically and scientifically the essential elements that impact on image and memory. It becomes essential and innovative, because the data connected with the Neuro-headset results, which guarantee to understand which part of the cerebral cortex is impacted by certain signals and in certain environments, giving analyses that can innovate the design criteria. The eye-track is an instrument composed of two cameras, one framing the observer's eye while the other records the surrounding environment. After a calibration and through an algorithm, it is possible to associate both the pupil’s movements and where it stares the environment. In this way, it is possible to record which elements the observer looks at and where he focuses most. It allows identifying in an objective way what are the most perceived elements in a given environment, and which consequently characterize it (Crosby and Hermens, 2018; Dufresne et al., 2017; Q. Li et al., 2016; Pieters and Warlop, 1999; Santos et al., 2015, 2015; Schiessl et al., 2003; Weichbroth et al., 2016).

The EEG helmet is a device that through electrodes records in a non-invasive way 14 channels (AF3, F7, F3, FC5, T7, P7, O1, O2, P8, T8, FC6, F4, F8, AF4) of the human brain and through an algorithm, it transforms them into cognitive states in real time (Kim et al., 2018). This is functional to the analysis of the behaviours (Aspinall et al., 2015; Berka et al., 2004, n.d.; Boutani et al., n.d.; Chynal et al., 2016; Gevins et al., n.d.; Hunter et al., n.d.; Itil et al., n.d.; Mavros et al., 2012; Sharma et al., 2017; Yadava et al., 2017). In fact, the raw data collected concerning brain impulses are interpreted by algorithms related to the EEG helmets and transformed into six cognitive states: valence, arousal, stress, meditation, focus, engagement (Badcock et al., 2015, 2013; Kotowski et al., 2018).

In the developed path, the combined use of the data was obtained through the criteria inherent in the circumplex model (Jonathan Posner, James A. Russell, 2008), an interpretative model updated over the years (Jonathan Posner, James A. Russell, 2008; Wioleta, 2013) which allows tracing back to emotions using only the cognitive states of valence and arousal (Yik, Russell and Steiger, 2011). With the valence value as first polar coordinate and the arousal value as second polar coordinate, it is possible to obtain a point within the circumplex model that represents the emotion of the observer. These points are associated with a unique color vector for each combination, transcribed in the RGB color space.

At the base of the reflection is the data fusion (B. Li et al., 2016) that allows us to read what man is attracted from and what the effects of perception on man are. In addition to the EEG data, the geographical position in real time is acquired simultaneously at a regular interval of one second. Thanks to the timestamp, it was possible to synchronize the GPS and the EEG data.

The experimental path leads to gathering data on the position and cognitive states of several testers. It is therefore necessary to find a way to compare the emotions of the different testers based on the spatial position. Through an algorithm developed in the Grasshopper visual script language for the Nurbs environment of Rhinoceros, it is possible to import the csv data of the experiments containing synchronized coordinates and EEG data, to identify in which positions the observations were taken from contiguous and comparable points. The plan referred to the space intakes was then subdivided into a grid with a pitch of 6m x 6m, correlated to the data uncertainty in the hypothesis that the subject moves with a speed of 1 meter per second. The algorithm developed then identifies which experiments are comparable and it calculates the average of the EEG and GPS values belonging to the same cell. In this way, we obtain the average emotion of the observers in space, represented by the data and the color of the circumplex model.

The representation of the data is possible using as a basis a mesh of the territory (DEM) object of analysis. The mesh was obtained through a photo-modeling process starting from the digital data of Google Earth, selected with a route of extraction of high-resolution photograms and reconstructed with specific software for the construction of models from photos in particular using (Agisoft Metashape). Juxtaposed to the mesh of the basic model is a vertex value consisting of a numerical attribute of the RGB color and therefore an expression of the circumplex model.

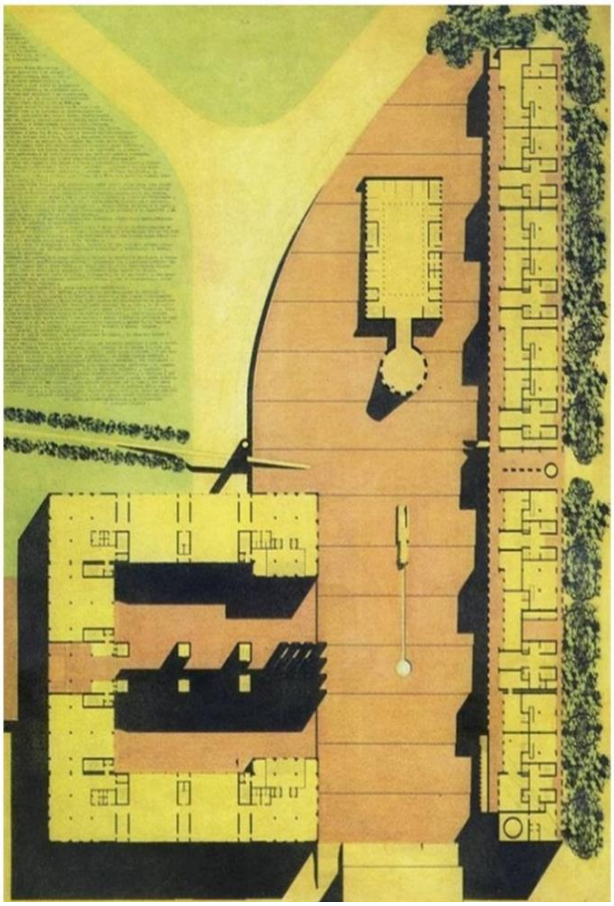

Figure 5– Original project of Aldo Rossi’s square.

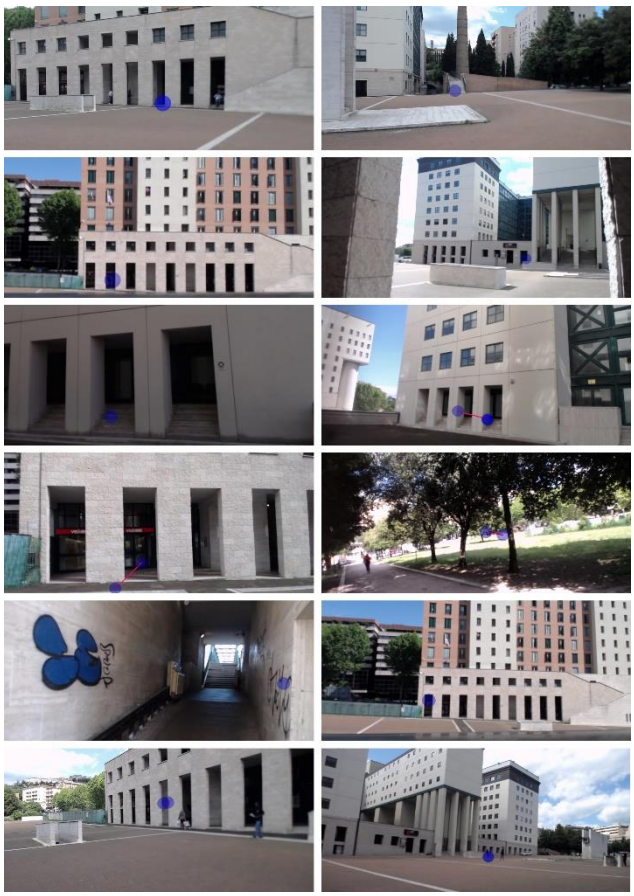

Figure 6 – Some frames of the recordings with Eye-Tracker in the current square. Circled in blue where the gaze rests, and in red the gaze rapid movement.

Finally, the faces of the mesh are colored by interpolating the vertex colors.
The representation thus obtained has a twofold objective: to store instrumental data and to represent them in an easily understandable way. The model, applied to the surveyed forms of the territory, colored with uniformity in the case of univocal emotions, it presents differences in correspondence with something that varies the sensations. On these sites, it is then possible to go on to further investigations, also using the data deriving from the data sampling and the done survey path with the EEGs, and simultaneously using the eye-trackers. These tools collect the coordinates on the projection plane related to fixation and gaze. It is then a matter of having further data, aligned with the timestamp, to highlight which are the mostly seen areas, which therefore seem to be the cause of the variation of the sensations. In this way, the various testers are implicit creators of a codesign path, as they highlight the key points of the landscape.

2.3 The case study

The case study is the Piazza Nuova in the Fontivegge area in Perugia, connected to the national public investment in the rail station area (more than 16 million of euros). This wants to support with innovation and research the development of deprived neighbourhoods, foster equitable access for all public spaces, enhance their quality and use, promote sustainable urban mobility patterns, reducing health-related environmental burdens in socially.

It is an area interpreted as dangerous, due to the failure to complete the architectural intervention, and on the other hand, to the same design choices of the famous architect Aldo Rossi (Rossi and Huet, 1984), linked to an idea of metaphysical architecture and stereometric forms marked by the rhythm of openings. It is then an area at the center of the debate, where one wonders if safety issues are linked to design choices.
Data acquisition took place by using EEG Emotiv Epoc +, Eye-Track Pupil and, for the geographical coordinates, a Samsung Gear S3.
There were 50 registrations and observers aged between 29 and 65, of whom 26 women and 24 men.
The experimentation began on the west side of Piazza del Bacio, after which the observer was free to roam inside it and in the surrounding areas.
The acquired EEG RAW data were processed by Emotiv PRO and exported in CSV format with the average valence and arousal metrics in regular intervals of 10 second. To synchronize them with the coordinates recorded every second, the average value was calculated every 10 seconds. In this way, each data is synchronized according to the timestamp at intervals of 10 second.
From the results, it emerges that the areas near the arcades, which partially surround the square, generate a strong feeling of "alert" in the test participants. Furthermore, the entrance areas to the square are polar, this are two: northward through a green area, and southward by two large staircases, of which the one towards the station is more alerting, probably being known to testers the habit of dwelling on such stairs from unreliable subjects. As evidenced by the eye tracking, the arcades are characterized by

Figure 7 – Records referred to a tester concerning the Arousal and Valence values recorded in function of time and of location.

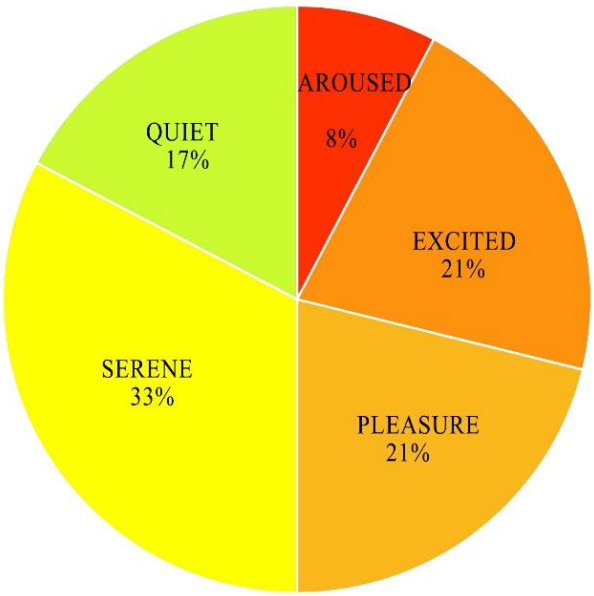

Figure 8 - Average emotional states in the square.

to the sense of insecurity. A slight slope, which implicitly characterizes an effort in the journey on one way and on the other it imposes an acceleration, marks the built square. This contrasts with the green area, which for the very qualities of its natural essence and probably because it is open and controllable, arouses relaxation and calm, emotions fragmented by a more turbulent excitement in the tree-screened borders. Analyzing data, it is possible to see the emotional state in the area, characterized by 29% of negative state, an important percentual considering the survey activity and a comparison with other experiences (Bianconi & Filippucci, 2019b).

3. CONCLUSION

The integration of different instruments, to be innovate in the project also by improving their performances, may lead to a combined analysis understandable only if the data are analysed through an interdisciplinary reading. The proposal then has the aim of defining methodologies for collecting data. It also wants to define interdisciplinary interpretative criteria to understand what is analysed, arriving to considerations of synthesis to be poured into the metaprojective field, to then test possible improvement solutions in the concerned areas and empirically analyse their impact.

With an interdisciplinary approach, through new devices, it is possible to analyse what man sees, what emotion he feels, how the environment influences his emotional state implicitly, which are the places and the conditions that favour welfare.

Moreover, studying the public spaces means promoting a vision centred on man that involves the active involvement of the users, taking into account the specificity of the contexts in which they act as they "really are" and not as they "should be". The codesign is implicated in these studies, the discipline deals with the human factor in order to study how man acts in his environment, in order to promote a truly inclusive design aimed at making people who live in it feel at home, feeling the spaces as their own.

The digital then becomes a real tool of Computer Aids Design, with digital data used not only to show the visible but also to make visible what is implicit in the relation between man and the environment. It is then a useful methodology to verify operationally the sense of places, which really and analytically focuses on emotions and meanings, and which is definable as a concrete methodology to analyze not only the territory and the environment, but also the landscape, intended as a result of the path of perception.

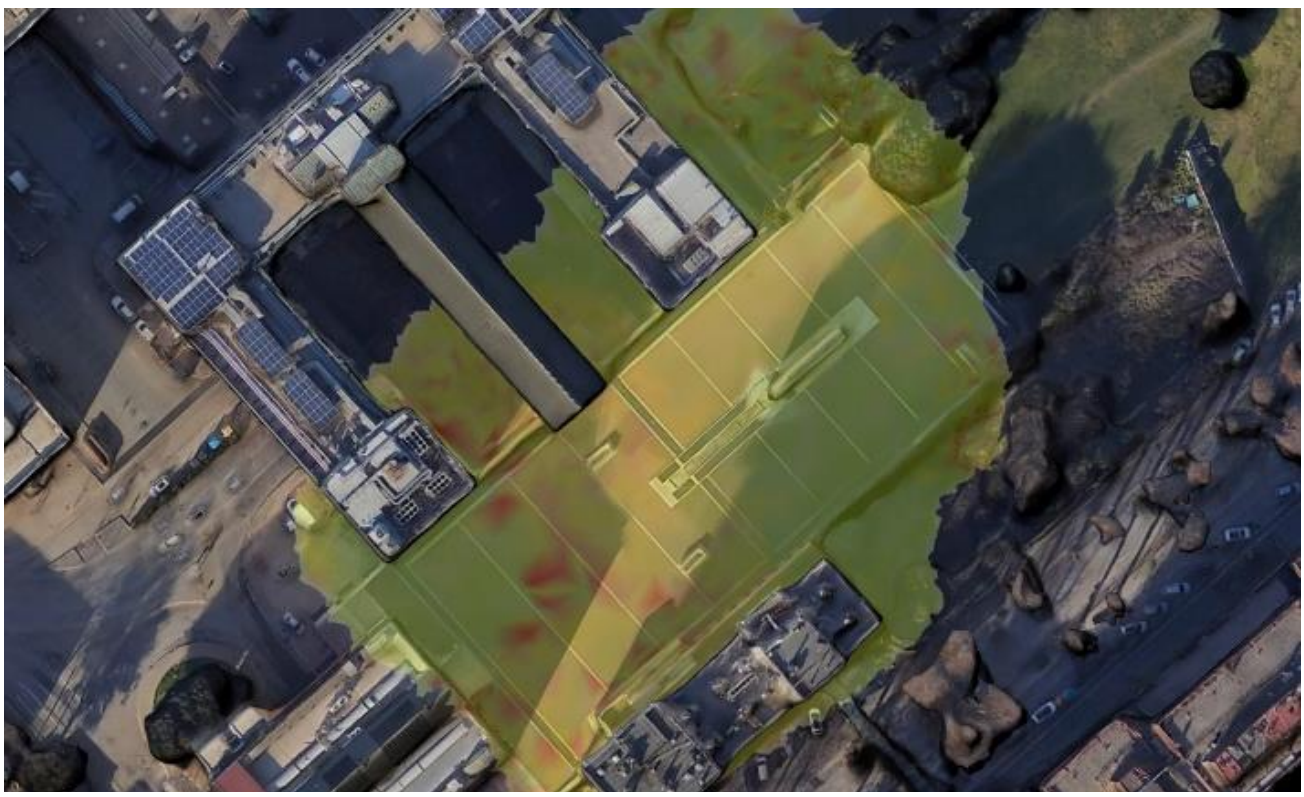

Figure 9- DEM in planimetric view with the addition of color attributes according to the EEG data related to the circumplex model.

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