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A critical view on the methodology used in ergonomics researches of built environment - Attribute Constellations

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1 Context

According to Ribeiro (2004) Ergonomics of the Built Environment seeks a more comprehensive approach to the study of the built environment that is better adapted to the abilities and human limitations. It also discusses key elements that are of great importance to the human / environment relationship, such as the human characteristics in the development of activities and tasks.

Under this understanding, the issues surrounding the triad built environment / human behavior / task performance, have supported the concepts of ergonomics of the built environment, based on environmental psychology and ergonomics.

In order to build an adequate environment to ergonomic requirements, meeting the above settings, it is necessary to have an accurate look at all issues inherent in the built environment. To this end, the ergonomics of the built environment uses methodologies, methods and techniques of ergonomics, architecture, universal design, environmental psychology, among others.

2 Brief overview of the methodologies used in the research of ergonomics of built environment

Aiming to give an overview of the methodologies used by the ergonomics of the built environment, analysis was performed on scientific papers published in the Proceedings of events that reflect the development of this area in Brazil in the last five years, as *Ergodesign* and *Eneac* meetings. This analysis included Ergodesign 2008 until 2012, and all editions of Eneac congresses.

Among the methods we verified the use of *Ergonomic Intervention (EI), Ergonomic Work Analysis (EWA)*, *Macro Ergonomic Work Analysis (MEWA)*, and *Ergonomic Analysis Method of Built Environment (EAMBE)*. We also verified the use of Post-Occupational Evaluation (POA), besides multi-methods there were not listed in any of these methodologies.

According to analysis of the scientific work, a higher use of the methods and techniques in interventions on built environment is guided by multi-method and refer to the use of (systematic and unsystematic) observations, inquiries (questionnaire and / or interview), photographic records, besides one or two techniques that are appropriate to the object researched. In such cases there is no record of the use of any of the aforementioned methodologies, conducting of methods, ways of data registry and their analyzes are at the discretion of the investigator or follow a specific protocol of the technique used.

3 Reviewing the methodologies applied in the Ergonomics of built environment

The methodologies used in ergonomics of the built environment researches are generally methods previously tried in ergonomics research, or adaptations thereof. However, it is necessary to focus on man - environment relationship.

The methodologies for ergonomic analysis of the environment are varied, which characterizes the complexity of approaches in regard to man and space. Four methodologies used are more recurrent in researches focusing on the built environment:

(1) Ergonomic Analysis of Work - EAW

Vidal, (2003) - Embracing and careful method of French origin, that enables a deep insight of the researcher about what happens during process or product or system handling. It aims to apply the knowledge of ergonomics to analyze, diagnose and fix a real work situation.

(2) Ergonomizing Intervation

Moraes &Mont'Alvão (2002) – This method is divided into five (5) major steps: Ergonomic Assessment (exploratory phase comprising mapping the ergonomic problems), Ergonomic Diagnose (allows further prioritized problems and test predictions), Ergonomic Projecting (adapting workstations equipment and tools to the user's physical, psychological and cognitive characteristics), Evaluations, validation and / or ergonomic testing (returning the pleas, proposals and project alternatives to users), lastly, Ergonomic Detailing and Optimization (project revision, after its review by the contractor and validation by users).

(3) Macro-Ergonomic Analysis of Work

Guimarães (2002) –It is an action-research of systemic character and eminently participatory, which is done with the users' participation in all project phases.

(4) Ergonomic Analysis Method of Built Environment - EAMBE

This methodology, proposed by Villarouco (2008), was planned in order to ensure adequate ergonomic space based on two phases: physical environment and the identification of the user's perception regarding that space. The analyze and recommendations are generated comparing the data obtained in both phases. In the first phase the study is based on Ergonomic Analysis of Work (EAW) that is used here as support to the physical aspects analysis of the built environment, where each of its steps was adapted, aiming to assess the environment in use. Regarding the identification of variables from users' perception, the author suggests the use of Attribute Constellation method, powerful tool in understanding of the environmental perception. Crossing the data obtained from these two tools, analyzes are performed in order to verify the relationships between the variables in the workspace.

The Attribute Constellation method: searching for the psychological consciousness of the user.

The Attribute Constellation method, idealized by Moles (1968) and later developed by researcher Jezabelle Ekambi-Schmidt (1974), through a spatial perception perspective, has been used in many researches in the field of ergonomics of built environment - especially in studies using the EAMBE method, as suggested by Villarouco (2008) when it comes to the investigation of the user's perception. This method is a strong tool that helps built space designers, as it aims to the knowledge of the users' psychological awareness in relation to space.

4 Understanding the application of the method

The application of the method consists of two stages. Firstly you should ask something like: "*what images or ideas comes to mind when you think of ... (a real object or theme)*." After answering that, a second question is made. This question seeks to collect data of to the studied environment, yet idealized: "*which images or ideas come to mind when you think of ... (an imaginary object)*." After obtaining the data, we should compile these through grouping of meanings and affinities, especially considering that similar responses will be merged into a single qualification. The attributes collected from these two questions are the elements needed to build a graphical model for each situation (real and imaginary), which will represent them in a clear and readable way, concisely and neatly grouped . The values obtained from the interviews are sorted according to their frequency of appearance in the answers .

The "psychological distances" according to Ekambi –Schmidt (1974) are calculated from the number of times certain attributes are mentioned. Firstly, determining the relative probability of association of an attribute to the object by a specific formula.

This data will allow us to set up the graph (*the constellation*), which center is the object of study, where the attributes are linked to the center by means of straight lines, creating connections from the responses obtained from the interviews.

5 The view of experts / psychologists involved in teaching the method and its application

From reading several published articles - mostly Masters researches - results on Ergonomics of the built environment, developed using the Attribute Constellation method, we noticed that some of the statements proposed by the method brought a sort of discomfort. According to the method it is possible to separate the stereotypical image of an area from its subjective image. Furthermore, the method developed by Ekambi-Schmidt (1974), states that the qualificatories (attributes) obtained through a general question related to the studied object, will not bring the idea of affectivity to the users of the environment studied.

5.1. Profile of respondents

In order to better understand the statements proposed by the Attribute Constellation method, we decided to develop a pilot test, through interviews with three experts with psychology training and extensive experience in academic research that seeks the psychological knowledge of the user. We understand that this is only a preliminary study, and we did not expect it to be conclusive; however, we believe it is able to contribute to the improvement of ergonomics of built environment research.

The interviews took place on different days and times during the months of September and October 2012, individually, in the city of Rio de Janeiro. Initially we applied the Attribute Constellation method to respondents, following the protocol provided in the methodology, using residential kitchen as the scenario for the research. Firstly we questioned about the real kitchen and then about the imaginary kitchen. These attributes were noted.

The method was explained to respondents through printed material, how it had been developed, its statements, form and application, collection of attributes, categorization, the graph with the results and finally, how it has been used in ergonomics of built environment researches.

After that, we asked the respondents (using a semi-structured interview) what was their understanding of the presented method, asking them to make some considerations on its application. The answers were recorded and then transferred to the notes.

The following are the considerations expressed by experts about the ascertained method.

Interview 1 - Did not understand why the attributes "are induced" - considering the question asked, there is no induction over the researched; disagrees the real attribute distances from the imaginary aspect; states that "*the subjective image is actually objective, since I am talking about my kitchen*", "*The method does not consider the separation of the objective and subjective aspects.* "

Interview 2- "*Stereotyped environment is not separate from subjective environment; there is no difference between everybody's kitchen and my kitchen. Not in that order. This separation is not relevant.*";"*The stereotyped one becomes the objective one, since this is the most imaginary of all.*" The professor also shows that as the frequency is very relevant, a small number of respondents, may lead to wrong results.

Interview 3- Does not believe it is possible to remove the idea of affection from the studied object; believing it is possible to get to satisfactory results if the number of respondents are representative enough (over 30 people).

Experts agree that the method is interesting in its application and very rich of information for researches, considering that the respondent is free to name the attributes relevant to the studied object (whether real or imaginary).

On the other hand, it is observed that the respondents do not believe in the separation of the stereotypical image of an area from its subjective image. It is also evident that the experts disagree when the proposed method does not consider affectivity ideas. A common point interviews is about the number of respondents in the use of the method: all claim that it is unlikely to obtain reliable results in studies using the Attribute Constellation method with a small number of respondents.

6 The Attribute Constellation, the mathematical point of view, and its interpretations.

The Attribute Constellation is an environmental perception analysis technique, by the user, with mathematics characteristics.

For this calculation, the following equation is used:

$P_i = \frac{n_i}{N} \times 100$, where

P_i - is the probability of association of attribute *i*
n_i - is the number of appearances of attribute *i*
N - is the total number of answers.

Once this calculation is done, a logaritmic funcion is used:

$$D = \frac{1}{\text{Log Pi}}$$, where

D - is the "*psychological distance*" of an attribute, in centimeters
P_i - is the probability of association of attribute *i*

Some considerations allow us to say that, from a mathematical viewpoint:

- The calculated value of P_i is proportional to the number of appearances of the attribute (n_i);
- When considering the same number of appearances of an attribute (n_i), in relation with a sample of respondent users (N), there is a proportionality between the distances obtained;
- The smaller number of appearances of an attribute (n_i), generates a greater distance to be plotted on the graph. This means that when we look at the graph, the greater distance is presenting an attribute that was cited less often by users;
- This allows us to say that the number of respondents will interfere with the display of attributes in the graph that is generated from the values of D.

7 Final comments / suggestions

The methods employed in the investigations of ergonomic issues, regarding the relationship of the user and the built environment, have contributed significantly in academic research, getting stronger with this ergonomics area. It means to say that frequent application of these methods enables the analysis of strengths and possible failings.

Through the interviews and discussion presented in this article we intend to contribute to the search of more effective methods. It is unlikely that we can separate the emotional aspects related to the product and the user; as well as we do not believe in the separation of stereotypical and real environments (in this context).

As for the number of participants in the interviews: it is understood that, since the number of respondents will influence directly the distances calculated for each attribute, according to the number of appearances, we advise to try to use the largest sample possible . In some cases, probably the entire universe of respondents should be heard.

Thus, the calculated distances can effectively represent, in a graphical point of view, the users' perception regarding the object studied.

We advise the need for more research in order to further investigate the search for users' psychological knowledge in the built environment; either by the Attribute Constellation method or by another method. There is still a long way to go.

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