HFD Human Factors in Design
PPGDESIGN UDESC

# METHODS FOR HUMAN FACTORS IN THE DESIGN OF BUS ARMCHAIRS

Rachel Corrêa de QUADROS[1], Flávio Nunes Vianna SANTOS[1], Noé Gomes BORGES Junior[1] Michaelle BOSSE[1]
[1] UDESC – Universidade do Estado de Santa Catarina

***SUMMARY***

*This paper discusses a bibliographic review portraying the product armchair versus humans. There was a feeling that this artifact is recognized as an integral part of the environment artificially produced by man, as it is the transportation segment, however, it is in a period little shorter than a decade that, in Brazil, the first studies on how its design can affect or interfere in the physical comfort of its users began. This study proposes to refer to theoretical approaches of the concept of comfort pervaded by ergonomics assumptions and by human factors.*

***KEYWORDS***

*Ergonomics, methods for human factors, bus seats.*

## 1. INTRODUCTION

The relationship between man and his artificially produced environment is an object of study in different disciplines, especially of the human factors, primarily related with the conception of artifacts. The context of the internal environment of a vehicle is towed to the man universe and his mobility, so it is essential to reflect on some assumptions of human needs. The theoretical postulates adopted throughout this paper include the following:

• physical comfort and discomfort in the bus seats;
• ergonomic concepts in the activity of sitting inside vehicles;
• concepts and methods of human factors.

The sitting position for a long time, as in the carrying of users in interstate buses, can cause discomfort in different aspects: from muscle fatigue, blood pressure, destabilization, postural muscle problems, especially in the lumbar region, among others. To this statement, Panero and Zelnick (2002) point out that one of the biggest problems is the perception that the sitting is often seen as a static activity, however, such action it is dynamic.

## 2. PHYSICAL COMFORT AND DISCOMFORT IN BUS ARMCHAIRS

From the point of view of comfort, the authors Reynolds (1993) and Pheasant (1986), disclose that comfort is the "absence of discomfort", and one can see in this statement that the user feels comfortable when he does not feel any discomfort or unpleasant sensations. The authors also argue that the perception of comfort may change depending on the time variable.

In presenting the aspect of research punctuated with comfort in projects development of bus seats, Lemos & Vingla & Moretto (2011), argue that the seats of buses and cars offer a lumbar support in backrest and thus do not meet the basic need of the body which is the body motion.

Through the reading and discussion of the results, it is observed that the paper presents relevant aspects in the opinion of road bus users, the approach of quantitative research indicates that the degree of discomfort of the passengers is primarily in the lumbosacral region and then finally in the neck.

On the question of why the passenger changes position the vast majority of the sample indicated that one changes position primarily because he felt uncomfortable, and then switches to prevent discomfort. The survey also pointed the factors which cause the most discomfort in the chair and in order of relevance, which are the following: legroom, seat height, backrest angle, support for neck and support for the back. The conclusion of the authors of the study indicated a dissatisfaction of bus passengers interviewed in relation to the discomfort of the chair used during the trip, and immobility in the seated position, the limitations of the chair and the resulting positions hinder the search for comfort by the user.

When the questioning is discomfort, Larica (2003) points out that "the forced immobility", in this case, is the main source of discomfort, aggravated by the pressure of the body on the ischial tuberosities, thigh, pelvis and trunk. In his turn, Viel (2000), states that the discomfort generated by body posture and sitting posture are situations that can strike any individual, because of poor adaptation of the environment and his individual characteristics.

However, when the discussion refers to mobility in a seated position, Moro (1994) states that in the seated position there is not only one but several positions, since the body maintains its balance. In the research by Soares (1983), the ideal sitting posture is the one in which the trunk, legs and thighs are at a straight angle, criticized by Basmajian and Mac (1977), who report the difficulty staying still in one position in the posture sitting, which makes hard attempt a definition of the standard posture. This is confirmed by Rasch & Burke (1987), being that these authors claim that each individual has its own bone and muscle constitution, it is unlikely the existence of a standard posture, verifying that the best posture is the one that allows the user periodic variations.

Seymour (1995) shows the importance of comfort in sitting posture, because the lack of constant movement in the chair contributes to the development of pressure ulcers, impairing movement, particularly in venous return, affecting the levels of flexibility of muscles and joints.

Carson (1993) reports that in the sitting posture, there is an increase in the pressure of the spine, thighs and buttocks, which may at the same time favoring the emergence of postures and its increasing if the subject remains seated a while longer. Sitting for long periods causes fatigue, especially in the neck and head, which could be alleviated with regular breaks during work or bus ride, Corlett and Manenica (1980).

## 3. ERGONOMIC CONCEPTS IN THE SITTING IN VEHICLE ACTIVITY

Correlating ergonomic aspects in the design of artifacts, especially in the area of transport, points to relevant issues such as: dynamic anthropometry of the human being when the movement of the "sitting" is studied is still a challenging activity.

However, it is necessary to identify what are the physical dimensions studied, for Panero & Zenick (2002), there are two basic types of body size with importance in the design of interior spaces: structural and functional:

> *"The structural dimensions, sometimes called static measures include the head, trunk and limbs in standardized positions. The functional dimensions, also called dynamic, as the term suggests, include measures taken in working positions or during a movement associated with a particular task. "PANERO & ZENICK (2002:27).*

The above quote expresses important aspects to reflect on the sizing and/or design of internal space for a vehicle. For this piece, it is referenced the position of the author Matshiner (2002, p.12), which identifies the development of internal spaces of vehicles as follows:

*Designing a functional internal space is a challenging task of the modern design of automobiles. The best design is always the one which translates the perfect combination between reason and emotion, between form and function, which selects the best material and put the entire inside space on the service of man. The interior of the Polo is the result of a detailed ergonomic study. It provides a friendly sense of order, balance, from the broad vision that one has of the cockpit.*

The use of seats, despite its constant presence and long history, since 2050 years BC, in terms of design, is still one of the poorest elements of the indoors. One of the biggest problems pointed out by the aforementioned authors is the perception that the sitting is often seen as a static activity, while in fact this action is dynamic. It is worth noting in this statement the following quote:

> *"The application of two-dimensional static data in order to solve a three-dimensional dynamic problem, and involving biomechanical is not a valid project approach. Paradoxically, a proper seat from an anthropometric point of view, may not be comfortable. However, if the project simply does not meet all the human and body dimensions, there is no doubt that the result will be the discomfort of the user. "PANERO & ZENICK, (2002, p. 7).*

The aforementioned authors indicate that it is essential that the selected data are appropriate to the user space or furniture to be designed by the task being performed. In this perspective it is clear that measure the levels of motor coordination, i.e., the moves given through a biomechanical evaluation is essential in the seats for vehicles designing, still the concept of "total comfort" will always be discussed.

Panero & Zenick (2002) argue further that the dynamics of "sitting" is most clearly illustrated when elucidating the mechanics of the system (seat height, seat depth, backrest, armrest, footrest and leg and upholstery) and skeletal muscle structure (bones, muscles, tendons, ligaments, cartilage, nerves and blood vessels) involved, but is more common to find tables that indicate the variables that involve a static sitting posture.

## 4. CONCEPTS AND METHODS OF HUMAN FACTORS

*Human Factors* is a term derived from ergonomics in the North American literature, which focuses on understanding the nature of the interactions between humans and artifacts, including a variety of products, processes and environments. Furthermore, the ergonomics focused on the human component, concentrates on the two major requirements of all scientific procedure: the generalization and the quantitative measure according to Montmollin (2005 apud Braazt 2012). According Braazt (op. cit.), the list of human components, traditionally studied by this current, emphasizes the following items: postures and movements, especially the biomechanical, physiological and anthropometric basis.

It is in this sense that one must associate its practice with the use of projective methods applied in the creation of a product (artifact) and/or service, and these should be linked to an industrial process of

production and consumption market. These projective methods are the ones that systematically program the idea of an idea, respecting the technical, productive, practical, functional and aesthetic aspects as well as the intrinsic cognitive elements on the user versus artifact experience.
Relate the human experience in both the physical and psychological aspects, with the form, handling and visual is the basic requirement to think a product. In addition to these aspects the production of this idea should respect a technological reality and a social context, i.e., understand the human being throughout his universe: material and nonmaterial.
We point here then another name for these factors, according to Dreyfuss (2002, p 12.)

> *"... human factors cover both physiology and psychology and cover most of the factors that affect human performance in activities involving tools in a built environment ... "*

To define human factors as the above author's perspective is to found that beyond the human question, there are other elements: tool and environment, which are also relevant in the experiment mentioned above.
The importance of ergonomics in design today is more comprehensive in the prospect of increasingly contribute to a greater appreciation of the "humanization of work", requiring ever deeper studies in aspects of physical and mental comfort, both cognitive and psychic, of the man and, if rightly exercised, can provide a response to the wishes of qualitative improvement in the workplace and, consequently, a better use of spaces in the public transport vehicles.
In an intuitive, ergonomic is already practiced since there is the man. The first weapons and tools were already adapted to people, moreover, there was a selection of those most able to wars and to perform certain specific functions. "It is necessary to facilitate the work, reduce discomfort, health risks and improve the quality of life," says VIEIRA (1998, p. 253).
Conjecture that the product development, especially that destined for the automotive industry requires its projectual grounds based on the interfaces between man *versus* machine *versus* environment, to establish usability, comfort and safety in this study scenario, it is the understanding that one of the foundation sciences to this interface is ergonomics in its scope, especially physics, integrated to biomechanics[1] concepts.
In the context of biomechanics one can cite some methods that assess the activity of sitting in interstate travel by cargo conference vehicles as buses. This is the case of some methods mentioned below:

- RULA (Rapid Upper Limb Assessment);
- REBA (Rapid Entire Body Assessment);
- Charging equation of NIOSH (National Institute for Occupational Safety and Health);
- OWAS (Ovako Working Posture Analysing System);
- Fatigue analysis;

[1] To assess human movements, it takes into account the approach of the Biomechanics and Kinesiology knowledges. The Kinesiology as the scientific study of human movement can be an umbrella term used to describe any form of anatomical, physiological, psychological or mechanics assessment of human movement. This knowledge area focuses on the study musculoskeletal, movements efficiency from the anatomical point of view and actions of the joints and muscles during simple and complex movements. The concepts of biomechanics were extracted from mechanics, an area of physics that consists of the study of motion and the effect of incident forces on an object. It was a natural transition the ownership of the mechanics tools and its application in living organisms. Hamill and Knutzen, 2008.

• Metabolic energy expenditure;

It is important to consider that the methods mentioned already have application softwares in product design.

## 5. FINAL CONSIDERATIONS

Understanding the concepts and applicability of methods that increase the quality of knowledge and development of artifacts is crucial to the pursuit the quality of life of users. To this end, it is understood that the need to search by technological change, increasingly seeking safety, economy and comfort in the use of the artifacts is a constant need. In the theoretical research on human factors, applied to the projection of products, it's been pointed out some effective methods for evaluation in the act of sitting in the segment of public transport as a work situation in which these tools have been validated.

The further studies aimed to evaluation methods applicable to product development for this segment will bring scientific progress given the lack of studies in this area.

In this way it is outlined a promising prospect for studies on transportation, which will shall combine in its practices the product development professionals in conjunction with public transportation agencies creating standards and guidelines, along with manufacturers, which define the policies aimed at welfare, safety and comfort, contemplating the needs and the expectations of users.

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