

# Noise analysis in professional office chairs

Alves, E. J. W., Filho, J. N., Silva, S. J. and Câmara, J. J. D.

*CEMA/LAB-laboratory of Sensory and Ergonomic Studies – Minas Gerais State University – UEMG, AV. Antonio Carlos, São Luis, postal code 7545, 31 270-010, MG, Brazil*

**Abstract.** The noise caused by the movement of users on their chairs in the work environment may indicate structural weaknesses and risk, and still significantly reduce productivity by increasing employees stress level. By understanding the activities to be developed in a work place one may understand what should be necessary to a good development, thereafter a search for improvement of labor activity with the aim of better use of resources in the operation of product use may be done. The analysis of the incremental variation of noise in professional chairs aims to identify its origin and the time the emission of noise starts during the period of use, its development and the major causative agents. Determining the characteristics of the sound of different materials and adjustments mechanisms of the chair can determine how different materials interact with each other. The measurement of these noises in an acoustic isolated room using directional microphones, if recorded and analyzed properly makes it possible to investigate and orientate to suspect elements in order to propose solutions and identify the quality of other similar chairs. Based on the results recommendations can be established for the orientation of users, managers and people responsible for the acquisition of the products, inducing them to review the employment of materials and the choice of the processes of production. These aspects are not covered in the Brazilian ergonomics norms and standards in the use of chairs.

Keywords: noise, stress, productivity, design, methodology

## 1. Introduction

The noise caused by movement of the user in professional office chairs, if not solved quickly can lead to stress or lack of attention of the people placed on this working environment, reducing its efficiency and enabling an irritability climate that will affect everyone.

A simple definition of noise can be described as any unwanted sound. It is called sound when it is not unpleasant, and noise when it disturbs people, according to K. Kroemer, and E. Grandjean, (2005:256). This definition is particularly good when applied with regard to noise at work.

Moreover, according to K. Kroemer, and E. Grandjean, (2005:256), the more intense and repetitive the noise is, the greater the damage to hearing. In addition, the noise that consists predominantly of high frequencies is more harmful than the low frequency noise.

Buyers who do not have reference data for the determination of their choice when defining the one for acquisition, are limited to the information passed on by the manufacturer, which often do not hold these data. It should be obtained from data measured

in samples of new products lots to ensure limiting the noise levels in most products.

The quality control of a product becomes more effective when the damage caused by its use during a period of time is measured. This measurement is directed to the adequacy of materials and processes for quality improvement, which is reflected on consumers perception of the company's brand which in turn demonstrates the public's trust on the corporation.

The noises emitted with the use of chairs can be caused by friction between materials or by its fatigue, and both can lead to rupture or break the product. This can lead to a possibility of an accident.

Intermittent noise due to movement in chairs can exceed 90dB when caused by small oversights in the manufacturing process if its subsystems are not properly planned. A simple chair in mono produced material can make noises during the use, because even seated we move, causing vibrations and friction between components. Operating chairs usually have adjustment systems that add components from different materials, being much more likely to react with each other and cause noise and fatigue. The noise caused by movement and

interaction of these materials may indicate the proximity of a collapse of any component.

According I. Iida (2005), although up to 90 dB noise do not cause serious damage to the hearing organs, noise between 70 and 90 dB impairs conversations and concentration which may cause increased errors and decreased performance. [...] A sudden sound of 100dB lasting approximately 5 $\mu$ s causes a scare, producing an immediate defense when the body is adopting a position of maximum postural stability. This type of reaction interferes at work and slows reaction time in other tasks.

Though little reported in bibliographies, the noises caused by operating chairs in an office and education environment is relatively common in Brazil, mainly due to the lower price appreciation over the quality of products.

## 2. Objectives

Determine the causative factors of noise in operating chairs used in offices and schools to future repairing, minimizing the rate of incidence.

### 2.1 Specific objectives

To guide business owners on the benefits resulting from measurement and control of operational noise caused in chairs, with the aim of improving product quality, customer loyalty and improve the corporate image.

To guide designers and developers operating in the specification of chairs and specification of materials and components in order to minimize errors, fatigue and noise in these products.

Advise clients, product users and specify about the sound quality of operational chairs.

To demonstrate the relationship of product quality to the noise emitted during use.

Creating a database of sounds that are emitted by materials that make up the object of study and the sounds emitted by the movement and interaction (friction) between materials.

To understand the potential of this study to issues of noise analysis, in order to use it as a tool for detecting and correcting noises in chairs.

Sensitize entrepreneurs to issue sound quality stamps as a means to guarantee to its customers the product's efficiency in the emission of noise during use for a certain period of time.

## 3. Bibliographic revision

[...] More attention should be given to the integration of ergonomics to product design. The ergonomic brings to design process a more systematic approach to the analysis, specification and evaluation of usability requirements. Ergonomics brings knowledge and techniques that increase the ability of the designer to design successful interfaces with the user (Beijing, SM, 2005 *apud* A. Moraes: cap.7p.5)

The data analysis of new products as well as those who are already in the market provides the knowledge of interference factors for product quality and safety for the user, enabling both innovations and to correction of possible design errors or improvements related to materials and production processes.

For M. R. Dias (2009) cited in Norman, (2006, p.133), the natural sounds reflect the complex interaction of objects: the way a piece moves against another, the material that the parts are made and their properties - hollow or solid, wood or metal, hard or soft, rough or smooth. The sounds are generated when materials interact, and they say to us they are shocking, sliding, breaking, tearing, or smashing. In addition, the sounds differ depending on the characteristics of objects in terms of size, strength, mass, tension and material.

M. R. Dias (2009) concludes that when these various oscillatory movements combine and produce a resultant movement, whose oscillation result is not in harmony, we have what is called noise. Thus, the noise is characterized by the existence of many frequencies and amplitudes occurring at the same time in a non-harmonic way, while the sound is characterized by a few amplitudes and frequencies, usually harmonic.

Failure to observe aspects of sound that can be caused by the relationship of materials, the building system or lack of assembly adjustment can lead, over a period of time and constant use of the equipment in the appearance of unwanted and incompatible sounds with the required characteristics, causing discomfort to the user and his distrust for the quality of the product.

S. M. Pequini, (2005:cap.7p.5), concludes that attending the ergonomics requirements enables maximizing comfort, satisfaction and welfare, ensure safety, minimize constraints, costs and human cognitive, mental and physical load of the user, and optimize the performance during the task,

the performance of work and productivity of the human-machine system.

Professional office chairs require high technical quality of ergonomic requirements, including noise through the use which can cause discomfort and irritation for both the user of the product and their work colleagues. On planning and development of these products should be watching the acoustic comfort of the user, in addition to the ergonomics of the seat, helping to prevent the causes of noise. Testing of use in the laboratory can establish the product's efficiency and user satisfaction.

Being the noise a complex mixture of various vibrations that can be measured on a logarithmic scale, which unit of measure the decibel (dB), its measure helps to identify the limits of emitted sound, provides an efficient and reliable measurement of the noise levels acceptable to the human being without affecting their work and their physical and intellectual integrity. However, the boundary between sound and noise cannot be precisely defined because every person has a different reaction to the sound or noise, which depends among other factors to emotional state and personality. Therefore, the acoustic discomfort or annoyance depends not only on the Sound Pressure Levels (SPL), but also the individuality of each person, mental state, physical condition and their willingness to accept at the time of the event.

According S. N. Y. Gerges, the human perception of sound cannot be measured only by one indicator (in dB SPL) because the perception is a multidimensional process that involves:

1. Psychoacoustic behavior;
2. Physic-acoustic behavior of the auditory system of both ears;
3. Previous experience of each listener and mental and physical state.

Gerges further emphasizes that Sound Quality attempts to quantify the human sound perception and evaluate the quality of the products on the acoustic point of view.

The psychoacoustics enables to determine subjective parameters of a group of people exposed to sound stimuli: perception, psychological and physiological reactions to noise, interference in daily activities, noise nuisance and others. These parameters lead us to conclusions that contribute to more assertive decision-making possibilities.

Colleoni and Cols *apud* L. B Medeiros (1999), comment that the low frequency range,

starting with the infra-sonic frequencies (below 16Hz), the effects of noise are not hearing, and among them are nausea, vomiting, dizziness, etc.. As the frequency increases, the effects are different and we can find changes in attention and concentration, breathing rate, heart rate, increased irritability, loss of appetite and pre-neurotic states. This statement is mainly related to vehicle seats, which transmit vibrations to the body or are close to sound sources of high intensity.

According to Alexandry *apud* L. B Medeiros (1999), there is a relationship between noise intensity and subjective effects. The sound, according to its intensity, may have somatic responses (peripheral vasoconstriction, decrease in breathing rate), chemical (glandular secretion of substances that produce chemical changes in the composition of blood and urine), and psychological (interference in sleep, tension, irritability and nervousness).

Seligman, *apud* L. B Medeiros (1999), states that the noise heard during the day can disrupt the sleep hours. Patients complain of difficulty in initiating sleep, insomnia, and frequent awakenings, which determines tired the next day.

A. Moraes *apud* S. M. Pequini (2005:cap.7p.4) says that for the design of interfaces with user of high quality products, we must place greater emphasis on the suitability of the product characteristics to the requirements and physical, perceptual and cognitive abilities of consumers and users in meeting the demands of the job and tasks that users intend to perform.

Faced with so much evidence and proof of harmful effects caused by noise and on the ability to plan each component of a chair through the actions of ergonomic design and engineering, we realize that they can offer products that meet user needs as expected. Therefore, it is necessary to predict the interaction of components and materials, production processes and construction, ergonomic standards, and aesthetic use, determine the longevity to be offered, and through laboratory tests, with measurement of results and revision of those fleeing the specifications, we can confirm the design specifications and meet the requirements.

#### 4. Development

The noise produced by the various components of professional office chairs for your use, efforts suffering in many ways, caused by the movement of

the user when seated, can be generated in the various components that comprise it, and be caused by different reasons.

Detect the origin of noise and its cause is an important factor for the industry to offer better quality products so that designers and developers can better understand these noises and prevent them in future projects. To redesign the project so to review the selection and quality control of materials used, production process and constructive applied to these products.

The issue of noise generated in professionals office chairs, as noted, can cause inattention, irritability, stress, disturbed sleep at night, among others, and may cause damage both to those who buy the product as for manufacturers, retailers and representatives from directly affect the corporate image of such organizations responsible for producing and marketing the same, and bear the discomfort of the complaints of dissatisfied customers, maintenance, repair and / or replace the product or components.

We note that in a given lot of chairs acquired in trade, at the same time, produced by the same manufacturer, some of these chairs provided noise after a certain period of time, and others not. Noise identified in those who showed different sounds and also were of different intensities. Another point that we noticed was that all chairs had lost components or misfits, both those which had or not, noise. Checking the level of noise emitted by one of the chairs being moved forward and backward, held close to the measurement of its structure, it was found that the noise reached 82dB, which, according to I. Iida, difficult conversation and concentration can cause increased errors and decreased performance of people who are embedded in the environment of the product in use, which resonates and psycho-physical damage to the user and members of the environment.

The concern in detecting the level of noise caused in chairs are just linked to operative interference that these sounds have on people's behavior and their interaction with others located in the same environment, which affects the emotional system and production of all these groups. The study of this problem can also lead us to collaborate in developing a methodology for the seat product design in order to improve its performance and sound undesirable aspects. At the same time we can raise awareness among entrepreneurs of the industrial sector of seats to give greater attention to

quality of its products as regards the amount of unwanted sounds that may be issued in order to benefit from the ergonomic human-object interaction as well as the image of your company to their customers and consumers.

## 5. Methodology

From the proposed objectives we started an investigation through a literature review on the matters addressed in the areas of ergonomics, process management and product engineering and design, promoting a confrontation with ergonomic data and audio, and in search of trials experiments and simulations with the object problem in different ways to promote seat.

It is important to understand the phenomenon of sound, psychoacoustics and physical-acoustic properties that affect the individuals to develop tests that can guide us to make decisions. Thereafter should be involved a group composed by physiatrist, medicine, biodesign, productive resources and human perception, among others.

The results should come from the statistical analysis and results, when will be observed the potential application and future value of the study.

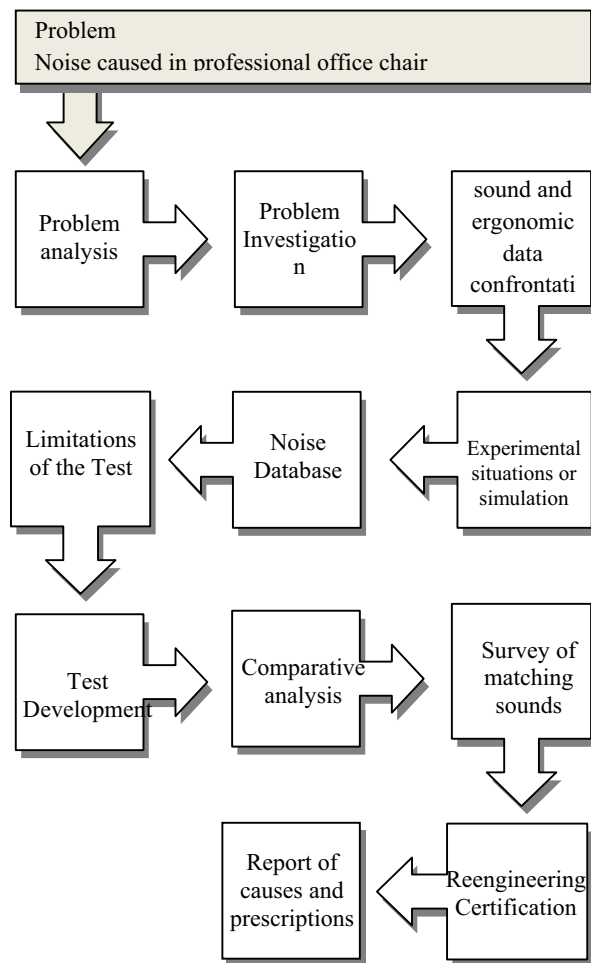


Fig. 5.1 – Outline of the research methodology of noise in professional office chairs.

The flowchart in Fig. 5.1 shows the methodology to be employed for the investigation of noise in professional office chairs.

For this research will use three chairs for the noise test, starting with the identification and measurement of noise in the “a” chair, which has the highest rate to be identified. Parallel, the “b” Chair, which features noise lower than the “a” chair will be dismantled to identify its components and to create a sound bank of materials and components that comprise it, as the Chair “c”, not is noisy, will be adjusted and tightened loose components to see if there was any change in the level of noise emitted.

After identifying all the noise detected and planned, as the materials that make up these chairs, the sound coming from the movement of the chair will be identified and compared with the sounds of

the database created, which will be used as a reference for the accurate identification the origin of the noise. Identified the source of these sounds, generating components are disassembled, analyzed and corrected through re-engineering techniques, as will be assembled and tested again to verify the methodology.

The flowchart in Fig. 5.2 below shows the method to be used in identification tests of noise in the professional office chairs.

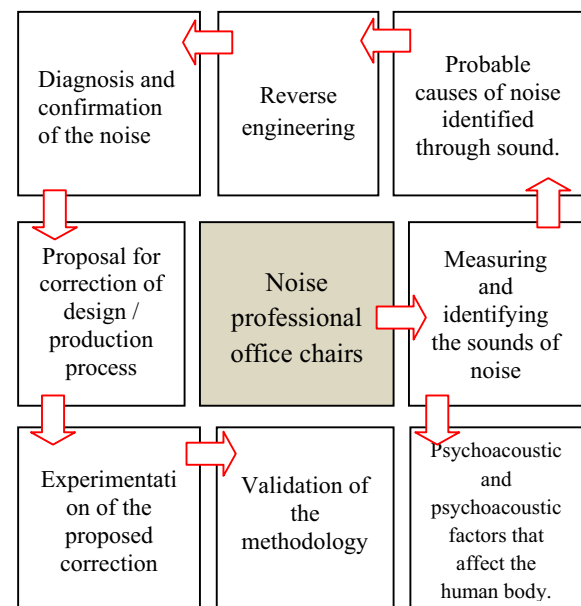


Figure 5.2 - Schematic of test methodology to investigate noises in professional office chairs

## 6. Conclusion

The development of this research will surprise us in many ways than the verification of the proposed objectives, because it is an investigation that began with a simple purpose, but involve complex factors such as psychoacoustics, physioacoustic analysis of sounds, behavior, environment, processes production, ergonomics, physical, biodesign, medicine and engineering, among others.

The specific objectives signal for the development of a methodology for measuring and identifying sounds that can also act as a tool to support sustainable actions when identify structural problems through the sounds, and thus enables a new way to boost identify and correct operational problems in chairs so you can fulfill its function again without harming people physically and psychologically.

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