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Theoretical Basis of the Parameters of the Base of Antique Chairs

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ABSTRACT

Frequently used furniture has a direct impact on the physiological and mental state of a person. It is important to know, to understand what ergonomic or aesthetic flaws are sometimes hidden when we are involuntarily dissatisfied with a piece of furniture. In the article, the design of antique chairs has been redesigned based on the requirements of ergonomics. The object of the study is the antique base of the chair, made in the medieval style. An antique chair has been redesigned using a prototype. The parameters of the redesigned chair support are theoretically based on ergonomic requirements.

KEYWORDS: *Prototype, antique, chair, wood, radius, basis, project, ergonomics, construction*

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1. INTRODUCTION

Frequently used furniture has a direct impact on the physiological and mental state of a person. It is important to know, to understand what ergonomic or aesthetic flaws are sometimes hidden when we are involuntarily dissatisfied with a piece of furniture. Anthropometric data is very important for many professionals, especially those working in the field of architecture and design, for manufacturers of industrial products, vehicles, as well as for measuring the level of premises, workplaces and government bodies.

Experience has shown that this compromise is economically justified and expedient. It occurs when a person is standing, sitting, or lying on their back while working. Depending on the manufactured product, the designer must take into account the object being designed. In some cases, the typewriters put folders and other items on the chair and under the legs due to the discrepancy between the size of the table and chairs. Sitting in an uncomfortable position tires a person, bends the spine, bends, deforms the body and leads to occupational diseases. Currently, the study of anthropometric data of different peoples, as well as children, adolescents, the elderly and the disabled is a cross-cutting problem.

This means that the anthropometric data of people living in the exporting country must be taken into account when preparing industrial exports. The reason is that studies show that 95% of people feel some comfort, and only 5% experience discomfort [1,2].

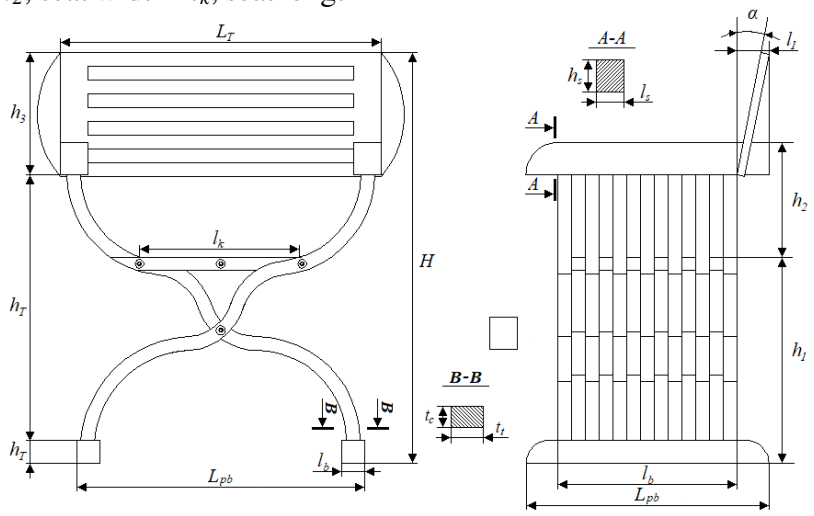
2. Methods

The object of the study is the antique base of the chair, made in the medieval style. In the course of the study, the rules of mathematical calculations, the rules of drawing, the AUTOCAD 2007 application program, the basic requirements of ergonomics and the methods specified in the current regulatory documents were used.

The design of the device has been redesigned taking into account the requirements of ergonomics. The redesign used the prototype design method. The design of the equipment was redesigned and a

medieval seat based on the technique was chosen as the prototype.

The main metric parameters of the reworked medieval seat design are: seat height - h_1; elbow height above the seat - h_2; seat width - l_k; seat length - l_b; distance between base supports - L_{pb}; distance between elbow pads - L_T; the angle of inclination of the seat back to the back - α; the distance to the back of the seat back is l_1.



a *b*

a – preview; *b* – side view

Figure 1 the design of the chair in the medieval style and its parameters

3. Results and discussion.

Let's start with the base, which is the basis for the theoretical substantiation of the metric parameters of the seat parts. The base of the seat has a complex shape and has four or three different radii of curvature. Determining the radius of curvature of the first curve (R_1) first requires determining the distance between the tops of the supports (l_T), the distance from the seat to the top of the support (a), and the distances from the edge of the seat to the base (b) (Figure 2).

The distance (l_T) between the upper parts of the supports is determined according to the scheme shown in Figure 1 by the following expression:

$$l_T = L_T - 2(l_s/2+t_t/2), \quad (1)$$

From this expression

$$l_T = L_T - (l_s+t_t). \quad (2)$$

where L_T is the distance between the elbow pads; l_s is the width of the elbow joint; t_t is the width of the base.

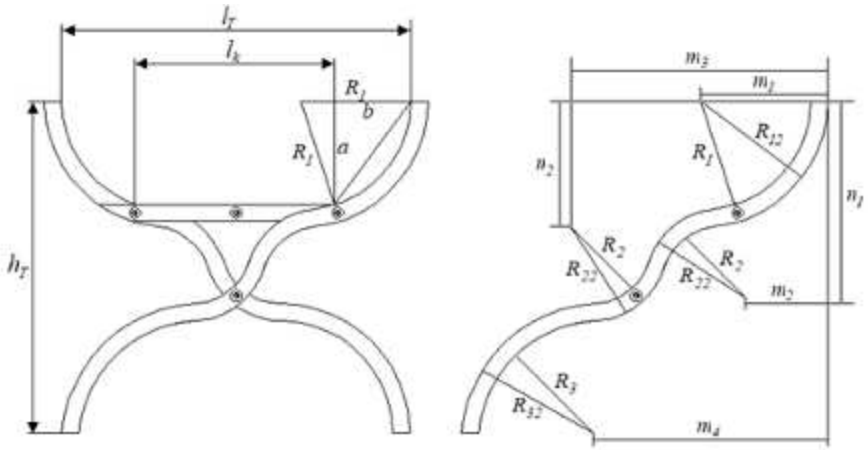


Figure 2 Scheme for determining the radii of curvature

The distance between the elbow pads (L_T) is assumed to be 700 mm based on human anthropometric data and ergonomic requirements cited in the literature [3, 4]. Assume that the width of the elbow rest (l_s) and the width of the support (t_t) are 60 mm and 30 mm from the dimensions of the existing seats.

(2) When calculating the known values of $l_s = 60$ mm, $t_t = 30$ mm and $L_T = 700$ mm, the calculations showed that the distance between the tops of the supports was $l_T = 610$ mm.

According to the diagrams in figures 1 and 2, the distance from the seat to the top of the support (a) is determined by the following expression:

$h_2 = h_s + a,$(3)

From this expression

$a = h_2 - h_s.$(4)

whereh_2 is the height of the elbow above the seat; h_s is the height of the elbow joint.

The height of the elbow above the seat (h_2) is assumed to be 250 mm based on human anthropometric data cited in the literature [4, 7]. Assume that the height (h_s) of the elbow is 70 mm from the dimensions of the existing seats.

(4) When calculating the known values of h_s = 70 mm and h_2 = 250 mm, the calculations showed that the distance from the seat to the top of the base was a = 180 mm.

According to the diagram in Figure 2, the distance (b) from the edge of the seat to the base is determined by the following expression:

$l_T = l_k + 2b,$(5)

From this expression

$b = (l_T - l_k)/2.$(6)

wherel_T is the distance between the upper parts of the supports; l_k is the seat width.

Assuming that the seat width (l_k) is assumed to be 350 mm based on human anthropometric data and ergonomic requirements cited in the literature [4, 5], the calculations are based on the values of l_T = 610 mm and l_k = 350 mm in expression (6) showed that the distance from the end point to the base was b = 130 mm.

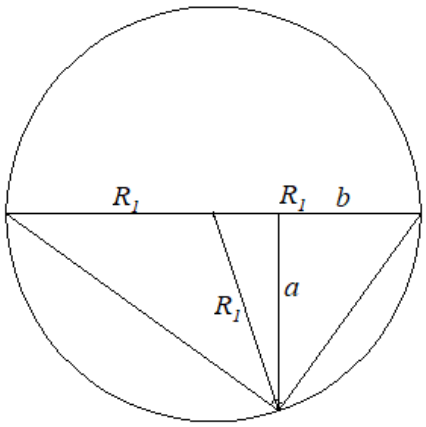
According to the diagram in Figure 3, the radius of the first curve (R_1), the distance from the seat to the top of the base (a) and the distance from the edge of the seat to the base (b) are as follows:

$a^2 + (R_1 - b)^2 = R_1^2,$(7)

From this expression

$R_1^2 = (a^2 + b^2)/2b.$(8)

Given that b = 130 mm and a = 180 mm, the calculations for expression (7) found that the radius of the first curve was 189.61 mm.



3-rasm. R_1 egrilik radiusini aniqlashga doir sxema.

According to the scheme in Figure 2, the radius of curvature $R_{12}$is determined by the following expression:

$R_{12} = R_1 + t_t.$(9)

Given that R_1 = 189.61 mm and t_t = 30 mm, the calculations for expression (9) show that the radius of curvature R_{12} is 219.61 mm.

According to the diagram in Figure 2, the distance m1 is equal to the radius of curvature $R_{12}m_1 = R_{12}$ = 219.61 mm.

Due to the complex shape of the chair back, we can assume the radius of the second curve (R_2) and the distances m_2, m_3, n_1, $n_2$in relation to the previous seats, ie R_2 = 104 mm, m_2 = 185.96 mm, m_3 = 412.85 mm ,n_1 = 321.86 mm and n_2= 250 mm.

According to the scheme in Figure 2, the radius of curvature $R_{22}$is determined by the following expression:
$R_{22} = R_2 + t_t$.(10)

Given that R_2 = 104 mm and t_t = 30 mm, the calculations for expression (10) show that the radius of curvature of R_{22} is 134 mm.

Using the known values R_1, R_2, m_1, m_2, and m_3, we can draw a diagram of the seat backrest using AutoCAD 2007 and determine the remaining R_3 and m_3 values using the diagrams and the distances h_T in the diagram shown in Figure 2.

The height (h_T) of the seat supports is determined according to the scheme in Figure 1 by the following expression:
$h_1 + h_2 = h_0 + h_T + h_s$, (11)

From this expression
$h_T = h_1 + h_2 - (h_0 + h_s)$. (12)

whereh_1 is the seat height; h_2 is the height of the elbow above the seat; hs is the height of the elbow joint; h_0 is the height of the seat base.

We assume that the seat height (h_1) is 450 mm based on human anthropometric data and ergonomic requirements cited in the literature [6, 7]. Assume that the height of the seat base (h_0) is 50 mm from the dimensions of the previous seats.

By calculating the known values of h_1 = 450 mm, h_2 = 250 mm, h_s = 70 mm and h_0 = 50 mm (12), it was found that the height of the seat supports was h_T = 580 mm.

In AutoCAD 2007, it was found that the h_T distance should be R_3 = 196.15 mm and m_3 = 376.58 mm when redesigning the seat backrest scheme according to the defined parameters (Figure 4).

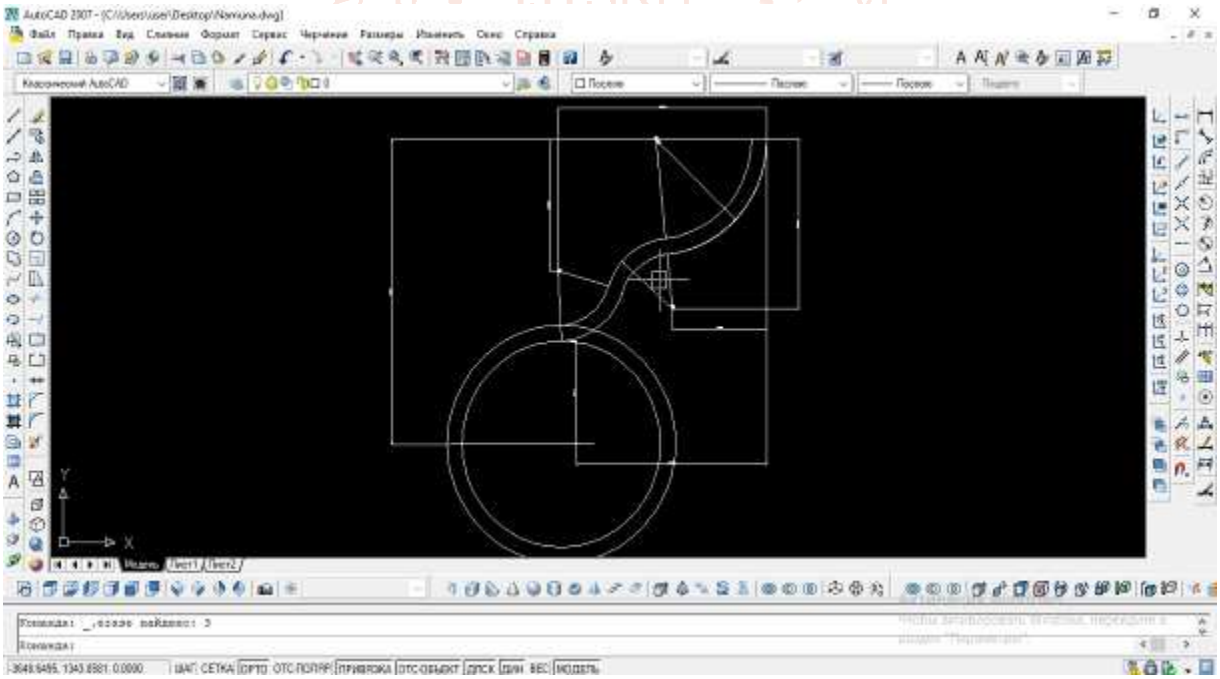


Figure 4 Determining R_3 and $m_3$values in AutoCAD 2007 application

According to the scheme in Figure 2, the radius of curvature $R_{32}$is determined by the following expression:
$R_{32} = R_3 + t_t$.(13)

Given that R_3 = 196.15 mm and t_t= 30 mm, the calculations for expression (13) found that the radius of curvature of R_{32} was 226.15 mm.

4. Conclusions

1. In the redesign of the chair base according to the prototype design methodology, its metric parameters were theoretically based on the basic requirements of ergonomics.
2. The selected chair support has a complex design with four radii of curvature. Calculations show that in order for the chair design to fully meet the ergonomic requirements, the radius of curvature of the support R_1, R_2, R_3 are 189.61 mm, 104 mm, 196.15 mm, respectively, and R_{12}, R_{22}, R_{32} are 219.61 mm, respectively. Should be 134 mm and 226.15 mm

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