ISSN: 2186-845X ISSN: 2186-8441 Print
Vol. 2. No. 2. April 2013

# DESIGNING AND FABRICATING A TABLOID CHAIR FOR STUDENTS FOCUSING ON ERGONOMICS

**Mohammad Iqbal[1], Salma A.Iqbal [2], Shibbir Ahmad[3]**

[1]Department of Industrial and Production Engineering,
[2]Department of CEP, Shah Jalal University of Science and Technology, Sylhet,
[3]Department of Industrial Engineering, East West Industrial Park Limited, Gazipur, BANGLADESH.

[3] shibbir36@yahoo.com

**ABSTRACT**

*Ergonomics is the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system, and the profession that applies theoretical principles, data and methods to design in order to optimize human well being and overall system performance. In this research, a chair has been design focusing on the ergonomic point of view and fabricating the chair based on the proposed design. A proposed design for tabloid chair was developed using anthropometric data taken from approximately 180 students whose feedback of using tabloid chair were taken b. In this research, we also analyzed the feasible cost of chair for bulk production in order to make this chair available to the market as a reasonable cost.*

**Keywords:** Design, Anthropometry, Cost, human factor, MSDS.

## INTRODUCTION

Ergonomics is about matching equipment to the user and the task to the worker. Another term used overseas for ergonomics is human factors. To apply ergonomics, we need to know about human capabilities and, of equal importance, what the person is trying to achieve.A fundamental issue in ergonomics is size. Humans come in a range of sizes. Not only are there those of us who are tall, short, thin or wide, there are those who have small hands, others with a long reach etc. One could imagine that there are as many different types of chairs as there are people of different height. It is an object that is available to most everyone. In its different embodiments it can be humble or regal, made of traditional wood or high-tech polymers, simple in concept or highly charged with meaning. Fundamentally, the requirements for a chair are few. It is essentially a horizontal surface at a logical distance from the ground meant to support the human body while sitting. A vertical surface is provided for back support. It can have arms or be armless. While these are the basic elements, a chair is more than the sum of its component parts. The psychological relationship with the user perhaps is stronger than with any other types of furniture. The form of a chair is comprised of three factors: function, aesthetics and material. Tablet arm chairs are widely used in educational institutions and business organizations. Space consumption by a tabloid chair is very low in comparison to its function. User sit on a chair for a long time will have fatigue or fill uncomforted when the chair will not be ergonomically designed for the long time use. For better performance perfectly designed chair should be provided to the user so that they will not feel any fatigue or discomfort. To get better performance the chair should be designed ergonomically.

## MUSCULOSKELETAL DISORDERS (MSDS)

Musculoskeletal disorders (MSDs) were recognized as having occupational etiologic factors as early as the beginning of the 18th century. However, it was not until the 1970s that occupational factors were examined using epidemiologic methods, and the work-relatedness of these conditions began appearing regularly in the international scientific literature. Since then the literature has increased dramatically; more than six thousand scientific articles addressing ergonomics in the workplace have been published. Yet, the relationship between MSDs and work-related factors remains the subject of considerable debate.

The World Health Organization has characterized "work-related" diseases as multifactorial to indicate that a number of risk factors (e.g., physical, work organizational, psychosocial, individual, and sociocultural) contribute to causing these diseases [a].

## REVIEW ON ERGONOMICS

Ergonomics is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance. A research on "A Benefits Study of Ergonomically Designed Chairs with Direct Labor Employees" was done by John C. Peck which Focuses on measuring changes in productivity related to ergonomic improvements [1]. Another research work was done by Abul Kalam Azad and Muhammad Salim Reza on "Designing an Ergonomic Chair for a VDT Workstation" , Department of Industrial and Production Engineering, Shahjalal University of Science and Technology [2].

Movement is essential for our well-being. Researchers have long known the negative consequences of constrained sitting [3]. People have difficulty tolerating unsupported, seated postures in static positions for more than a short while [4]. [5] Describes a pneumatic device they developed to induce continuous passive of motion in the lumbar region in order to negative some of the detrimental aspects of constrained setting. When allowed to move freely, people are usually in constant motion [6]. They often alternate through pastoral cycles continuously over the day [7]. Unfortunately, today's computer workers' are becoming increasingly constrained as the work process systematically automates activities that previously required changes in posture [8].

Such research demonstrates that constrained postures increase discomfort and health and risks .[9] Reported higher incidences of discomfort and chronic disorders among workers assuming fixated or constrained sitting postures. Static and constrained postures interrupt blood flow in direct proportion to the loads acting on the muscles [10] .Muscle oxygenation is reduced with fairly low loads [11].

## RESEARCH METHODOLOGY

1. To Setup ergonomics problems survey plan at Shahjalal University of Science and Technology, Sylhet, Bangladesh.
2. Preparation of questionnaire to support ergonomic problem survey and to distribute questionnaires to the sample.
3. Collection of data and analyzing this data for identification and prioritize the problems and prepared improvement plan by following ergonomics guideline.
4. The necessary anthropometric dimensions of the population are obtained or approximated from the result of the available anthropometric surveys reasonably represent the user group.

ISSN: 2186-845X ISSN: 2186-8441 Print
Vol. 2. No. 2. April 2013

5. Developing new tablet arm chair design for complying data of mainly population anthropometry.

## FINDINGS AND ANALYSIS

The study focuses the users of tabloid chair who are the university students of Bangladesh. The aim of this study is to find out the problems faced by the user and their recommendation which will help in designing a new tabloid chair. Also, it will help in describing the scenario of the existing tabloid chair. So for accomplishing the goal, a survey was conducted on 160 users of different tabloid chairs from Shahjalal University of Science and Technology, Sylhet, Bangladesh. The majority of the population is male. The majority of the population weight ranged from 55 kg to 70 kg. The majority of the population age ranged from 20 years to 23 years.

The data has been gathered through questionnaires. Every Questionnaire is taken from user after they spent minimum 1 hour sitting on tabloid chair. Questionnaires consist of two parts. One to find out the problems faced by the users and the other for identification of users' recommendations. Finally all data has been analyzed by using various types of tables and graphs.

### Determination of Average Time Spent On a Tabloid Chair by a User

Various types of pain faced by a user of a tabloid chair must be depend on the time duration usually s/he spent sitting on the chair. The data about average time spent by a user was processed and tabulated in table 3. Out of 110 users 25 users spent 1 hour, 20 users spent 2 hours, 35 users spent 3 hours and 28 users spent 4 hours.

**Table 1. Average time spent by the user on tabloid chair**

| *Duration* | *1 hour* | *2 hours* | *3 hours* | *4 hours* |
|---|---|---|---|---|
| Number of users | 31 | 36 | 49 | 34 |

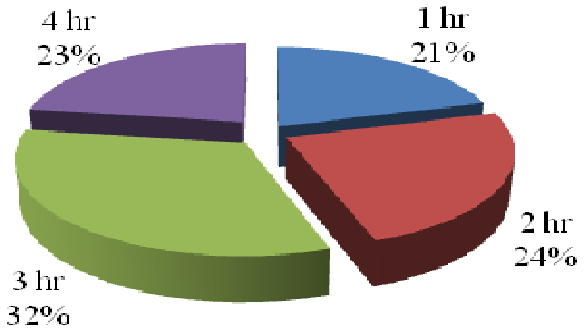


*Figure 1. Average time spent on a tabloid chair by a user*

By using data from table 1, a pie chart was developed, which shows that 21 percent of the population usually sits 1 hour, 24 percent sits 2 hours, 32 percent of the population sits 3 hours and 23 percent population sits 4 hours.

### Assessment for Frequency of Pain Felt by Users

The frequency of pain felt by the users depends on some factors such as sitting duration, condition of the seat and some other minor factors. These survey asses the pain felt by the user while they are sitting on the chair. After processing of the data it is seen that 22 users felt no pain, 111 users felt pain sometimes and the number of users who felt pain always was 17 (*see table 2*). Using this data a pie chart shows the number of users in terms of percentage.

**Table 2. Frequency of pain felt by users**

| *Frequency* | *Never* | *Sometime* | *Always* |
|---|---|---|---|
| Number of users | 22 | 111 | 17 |
| Percentage | 16 | 27 | 11 |

### Assessment of the Condition of the Existing Seat Pan

One of the major causes behind the pain felt by a chair user is the condition of the seat pan. For a poor seat the user can feel pain in the thigh and the posture. To assess the present condition of the seat five categories were selected which is from very bad to excellent. The rating of the tabloid chair users is shown in table 3.

**Table 3. Condition of the existing seat pan**

| *Condition* | *Very bad* | *Bad* | *Fair* | *Good* | *Excellent* |
|---|---|---|---|---|---|
| Number of users | 10 | 36 | 68 | 34 | 2 |
| Percentage | 7 | 24 | 54 | 23 | 1 |

### Assessment of Comfort Ability of the Existing Chair

To find out the comfort ability of existing chair a scale of 1 to 5 was selected, which allow users to rate the chair they are using. The assessment shows that the majority of the chair's comfort ability is average. From Table 4 it is clearly seen that a large number of users rate their chair 3. 22 users felt very low comfort. 34 users rated 2 and 8 users rated 3.

**Table 4. Comfort ability of the existing chair**

| *Rating* | *1* | *2* | *3* | *4* | *5* |
|---|---|---|---|---|---|
| Number of users | 22 | 34 | 83 | 8 | 3 |

### Assessment of Tab Height of Existing Chair

Tab height is a vital factor in tabloid chair. Inappropriate tab height causes elbow, shoulder and neck pain. Inappropriate tab height refers both the tab which is above and lowers comparing to elbow rest height. Table 5 shows that tab height is appropriate for 51 users (out of 108) and 57 users feel that the tab height is not appropriate for them.

**Table 5. Suitability of tab height**

| *Tab height* | *Appropriate* | *Inappropriate* |
|---|---|---|
| Number of users | 51 | 57 |

ISSN: 2186-845X ISSN: 2186-8441 Print
Vol. 2. No. 2. April 2013

### Assessment of Pain on Hand While Writing

The frequency of pain felt by the users while writing depends on the factors such as tab height and tab size. Improper tab height is responsible for shoulder and neck pain. Elbow and wrist pain causes due to improper tab size. 21 users do not feel any problem which means that tab height is appropriate for them. 111 users sometimes feel pain that means if they were sitting for a long time which causes pain and if the duration is small, they do not feel pain. 18 users always feel pain on hand while writing.

**Table 6. Pain felt by the user while writing**

| *F* | *Naver* | *Sometime* | *Always* |
|---|---|---|---|
| Number of user | 21 | 111 | 18 |
| Percentage | 14 | 74 | 12 |

**Table 7. Various types of problems and their causes**

| *Problems* | *Number of population* | *Causes* |
|---|---|---|
| Shoulder pain | 9 | Improper tab height |
| Neck pain | 31 | Improper tab height, back rest angle |
| Elbow pain | 46 | Improper tab height and size |
| Wrist pain | 7 | Improper tab height and size |
| Back pain | 41 | Improper back rest angle |
| Lower back pain | 8 | Improper back rest angle and seat depth |
| Posture pain | 35 | Poor Condition of seat pan |
| Thigh pain | 33 | Improper Seat height and depth |
| Knee pain | 12 | Improper Seat height |

### Assessment of health problem faced by users

Various types of pain and their causes are tabulated in Table 4.7 with affected user.

From table 7 it is seen that the majority of the user feels elbow pain (46), back pain (41), posture pain (35), thigh pain (33) and neck pain (31). Because of existing tabloid chairs tab height, backrest angle and seat pan inappropriate for those users. So there is a lot of scope to improve the condition of the existing tabloid chair.

### Preferable Chairs for Classroom Purpose

The study tries to find out which kind of chair preferred by user for classroom purpose.

Table 8 shows that the majority of the population prefers armless chair with foam, wood and metal which is about 40 percent. Preference for tabloid chair is 29 percent. The armless wooden chair is preferable to 15 percent and 15 percent for arm chair.

**Table 8. Preferable chair for classroom purpose**

| *Types of chair* | *Tablet arm chair* | *Armless wooden chair* | *Arm Chair* | *Stool* | *Armless chair with foam* |
|---|---|---|---|---|---|
| Number of users | 43 | 23 | 22 | 1 | 61 |
| Percentage | 29 | 15 | 15 | 1 | 40 |

### Preference of Tablet Arm Chair for Classroom Purpose

The nowadays tabloid chair is common in the classroom because it consumes lower space in comparable to other combination of chair and desk. To find out the user's preference of tabloid for classroom purpose a scale of 1-5 was developed. Maximum 42 user mark 3 and 2nd maximum 23 user mark 4 in scale of 5.

**Table 9. Preference of tabloid chair**

| *Rating* | *1* | *2* | *3* | *4* | *5* |
|---|---|---|---|---|---|
| Number of users | 26 | 30 | 57 | 32 | 5 |
| Percentage | 17 | 20 | 38 | 21 | 4 |

### Assessment of User Requirement

The table below shows the users' requirements in terms of Seat height and tab height.

**Table 10. User requirement**

| *Feature* | *Total population* | *Yes* | *No* |
|---|---|---|---|
| Seat height Adjustability | 110 | 83% | 17% |
| Tab height Adjustability | 110 | 89% | 11% |
| Space for bag/file | 110 | 98% | 2% |

## CONCLUSION

The analysis tried to find out the present scenario of tabloid chair and users requirement on tabloid chair. This analysis shows that the majority of the users have no knowledge about ergonomics. Large number of users felt pain in body while sitting on chair and most of the users say that tab height and size is not appropriate for them. Only 18 percent feel comfortable sitting on an existing tabloid chair. Users used to sit on a chair for 1-3 hour without any break. For better performance of user in the classroom an ergonomic tabloid chair is required. The next section will describe the design of the proposed tabloid chair.

## DESIGN AND FABRICATION

After the completion of the analysis of various health problems faced by the user of tabloid chairs, it was seen that nobody felt comfort except a small portion of the population, which means that there is an opportunity to improve the comfort ability of the tabloid chair.

ISSN: 2186-845X ISSN: 2186-8441 Print
Vol. 2. No. 2. April 2013

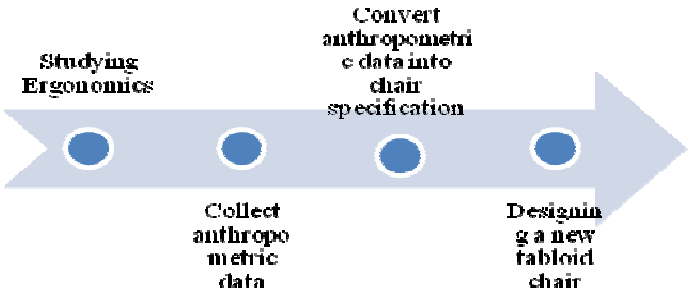


Figure 2. Method of tabloid chair design

It was seen from the previous section(4) that 70 percent user sometime feels pain and 12 percent user always feels pain, where the pains are on back, elbow, neck and posture. The reason behind this is the improper match between user and chair, which is not designed ergonomically. This section will show the design procedure of a tabloid chair using ergonomics guidelines. Anything that's supposed to design according to ergonomic principles requires anthropometric database, which should be taken from such population for which the design is being developed. Here the design is being developed for the student, Dept. of Industrial and Production engineering, Shahjalal University of Science and Technology, Sylhet, Bangladesh. Anthropometric data of 200 students were collected and processed for designing a new tabloid chair. The method of design that had been used is given in figure 2.

**Anthropometric Data**

Anthropometric data were collected from 2007 batch to 2010 batch student and data was tabulated in Microsoft excel. Using a statistical formula named *percentile*, which returns the k-th percentile of values in a range. To calculate $95^{th}$, $50^{th}$, $5^{th}$ percentile of various anthropometric measurement, the values of k =95, 50, 5 were used. The processed data are shown in Table 11.

**Table 11. Anthropometric data of 95th, 50th and 5th percentile**

| *Specification* | *Measurement* | *Value* |
|---|---|---|
| *Seat height* | Popliteal height + shoe allowance 3.81cm | 49cm |
| *Seat depth* | Buttock popliteal depth – clearance 12.7 cm | 37cm |
| *Seat width* | Hip breadth × cloth allowance 1.3 | 43cm |
| *Backrest height* | Sitting shoulder height × 0.8 | 45cm |
| *Tab height* | Sitting elbow height + allowance | 25cm |

A. Seat height: The chair sitting height is the vertical distance from the floor to the highest point on the front of the seat. The seat height is calculated for $5^{th}$ to $95^{th}$ percentile.

Seat height = $95^{th}$ percentile of Popliteal height + shoe allowance 1.5 inches (3.81cm)

A. Seat depth: The chair seat depth is the horizontal distance from the back of the sitting surface of the seat to its front. The chair seat depth is calculated from the Buttock popliteal depth. There must be a clearance between the back of the knees and the front of the seat. The clearance should exist for approximately 4 to 5 inches, measured from the leading edge of the chair. That means seat depth will be 4 to 5 inch less then Buttock popliteal depth.

Seat depth = 95$^{th}$ percentile of Buttock popliteal depth – clearance 5 inch (12.7cm)

B. Seat width: The chair width is the horizontal distance from the outer left side of the sitting surface of the seat to the outer right side. Hip breath is the considerable measure in case width.

Seat width = 50$^{th}$ percentile of hip breath + cloth allowance = hip breath × 1.3

C. Backrest height: The backrest height is the vertical distance from the top side of the seat surface to the highest point of the backrest. The backrest height is calculated from sitting shoulder height.

Backrest height = 95$^{th}$ percentile of shoulder height × 0.8

D. Backrest width: The American National Standard Institute (ANSI) recommended backrest should be at least 30cm wide in the lumber region.

E. Backrest angle: Backrest angle was selected 105° according to ANSI.

F. Tab height: The tab height is the vertical distance from the top side of the seat surface to the highest point of the tab surface.

Elbow height and thigh clearance are the considerable measure in case tab height.

Tab size: Tab size is related to the paper size. Most of the paper size is 10 "-12 "length and 7"-9" width. So tab size will be 12"×12".

## Design

Based on the findings, design guidelines, recommendations and using the anthropometric data and percentile range, the designed tabloid chair, seat pan, the tab and back rest is shown in the following figure. This design was done by using AutoCAD 2004.

## Detail Design

This section includes top view, front view and R.H.S view of the proposed tablet arm chair.

Figure 3. Isometric view of the proposed Tablet arm chair

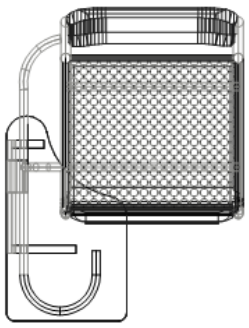

Figure 4. Top View of the Proposed Tabloid chair

ISSN: 2186-845X ISSN: 2186-8441 Print
Vol. 2. No. 2. April 2013

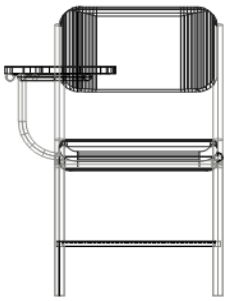

Figure 5. Front View of the Proposed Tabloid arm chair

Figure 6. Right Hand Side View of the Proposed Tabloid arm chair

**Material Selection and Cost**

The material selection depends on the design feature, aesthetic and user requirement of the product. Generally wood, steel (hollow round and square, angle) bars, foam, plywood and particle board are used in car manufacturing. Wood is mostly used in the manufacture of chair. It can be used in every part of the chair and comparatively low cost. Metal or steel bar is used to make the frame of the chair. Metal has good strength and machine ability. Its life long this more than the wood. Foam is usually used in the seat and backrest of the chair to produce a soft surface on the seat and backrest. Plywood is used in seat, backrest and tab of the chair. Hollow square steel bar, foam and particle board are selected for proposing design. The reasons behind the selection of those materials are given below.

Hollow Square Steel Bar: Square bar was selected for the frame of the chair. It can be bent to a certain angle which reduces time and machining cost.

Wood: To support the foam of the seat pan and backrest wood sheet was selected. Wood is fastened to the steel by means of screw to provide a support for foam.

Particle Board*:* Tab is an important component of a tabloid chair. Tab should be strong and rigid enough to provide support to hand while writing and also light in weight. For this particle board is selected for making tab.

Foam: About 53 percent users prefer foam as seat pan material. So, in fulfilling user preference foam was selected as seat pan material. It is also used in back rest.

**BOM (Bill of Material) of the proposed tabloid chair**

Bill of material of the proposed chair is givthe table table below:

**Table 12. Bill of Materials**

| *No* | *Items* | *Quantity* | *Price in Taka* |
|---|---|---|---|
| 1 | Round pipe | 20 ft | 480 |
| 2 | Wood | 3.1 $ft^2$ | 160 |
| 3 | Net | 1.723 $ft^2$ | 200 |
| 4 | Rexene | 4.5 $ft^2$ | 210 |
| 5 | Foam | 30 g | 30 |
| 6 | Particle Board | 1.62 $ft^2$ | 120 |
| 7 | Cap | 10 piece | 20 |
| | Total Cost | | *1220* |

## CONCLUSION

The use of tabloid chair of classroom is increasing day by day. Without proper design, sitting require greater muscular force and control to maintain stability and equilibrium. This in turn results in greater fatigue and discomfort and is likely to lead to poor postural habits as well as neck or back complaints. The most common problem faced by the users of tabloid chair is elbow pain. Out of 160 users 22 users did not face any pain when writing, while 138 users did. Among these 138 users 46 users specified that they are facing elbow pain. Back pain is second one mostly faced by the user. 41 users out of 160 users felt back pain. Due to lack of knowledge about ergonomics many users didn't specify where they felt pain. In this research, we have tried to design a tabloid chair, which will gain more advantages to the students. This paper addresses a better approach designing chair, which will provide support to the body in order to eliminate unexpected stress.

ISSN: 2186-845X ISSN: 2186-8441 Print
Vol. 2. No. 2. April 2013

## REFERENCES

[1] Abdul Kalam, Md., Azad & Salim Reza, M. (2004).Designing an Ergonomic chair for a VDT workstation, Department of Industrial and Production Engineering, Shah Jalal University, Sylhet, Bangladesh.

[2] Peck, John C. (1992). A Benefits Study of Ergonomically Designed Chairs with Direct Labour Employees. *International Journal of Clothing Science and Technology, 4*(2/3), 39 – 44.

[3] Adams, M. A. & Hutton, W. C. (1983). The effect of postures on the fluid content of lumber intervertebral discs .*Spine, 8*(6), 665-671.

[4] Reinecks, S., Benis, T., Weisman, J., Krag, M. & Pope, M. (1985). *The relationship between seating postures and low back pain*. Rehabilitation Engineering Society of North America, 8th Annual Conference, Memphis, Tenn.

[5] Rednecks, S. M., Hazard, R. G., Coleman, K. & Pope, M. H. (1992). A continuous passive lumbar motion device to relieve back pain with prolonged sitting. In: S. Kumar (Ed.) *Advances in Industrial Ergonomics and Safety IV*, London: Taylor and Francis.20, 971-976.

[6] Branton, P. (1969). Behavior, body mechanics , and discomfort, In: Grandjean, E. (Ed.) Sitting Posture *: Proceedings of a symposium held in September 1968 at the Swiss Federal Institute of Technology*. London: Taylor and Francis, 202-213.

[7] Branton, P. &Grayson, G. (1967). An evaluation of train seats by observation of sitting behavior. *Ergonomics, 10*, 35-51.

[8] Grieco, A. (1986). Sitting Posture: an old problem and no one. *Ergonomics, 29*(3), 345-362.

[9] Graf, M., Guggenbuhl, U. & Krueger, H. (1995). An assessment of seats activity and postures at five workplaces. *International J Industrial Ergonomics, 15*(2), 81-90.

[10] Grandjean, E. (1987). *Ergonomics in computerized offices*. London: Taylor and Francis. 96-156.

[11] McGill, S. M., Hughson, R. L. & Parks, K. (2000). Lumbar erector oxygenation during prolonged contractions: Implications for prolonged work. *Ergonomics, 43*(4), 486-493.

[12] WHO [1985]. Identification and control of work-related diseases. Geneva, Switzerland: World Health Organization. WHO Technical Report Series 714.