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DESIGN AND DEVELOPMENT OF BARBER CHAIR CONSIDERING ERGONOMIC FACTOR

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ABSTRACT

Ergonomics is the scientific discipline concern with the design of system to optimize human comfort. While designing any mechanical system besieging human's ergonomics is the most important aspect that must be taken into consideration. This paper gives an approach to think ergonomically while designing the barber chair. Everybody focuses on the comfort of customer while designing the chair but there is growing need to consider the comfort of barber also. A survey was conducted to study the problems faced by barber while working. A new seating arrangement is designed and developed for the barber considering all the problems faced by him. The arrangement can withstand the load of 120kg, which is validated by performing static analysis on the chair in FEA software ANSYS™ .The effect of fatigue experienced by barber is also considered. Results obtained using FEA shows close resemblance with those obtained using analytical method and by experimentation.

Keywords: Ergonomics, Design, Cost.

I. INTRODUCTION

Chairs are highly preferred for their high functionality, flexibility and low space requirement. In modern society, hairdressers spend lot of time on their work on a daily basis. If the chair is not properly designed to fit, support and better equip to the hairdresser, user fatigue and discomfort is unavoidable. [4] The current design of the ergonomic barber chair, which was formulated by our forerunner, contains some obvious flaws.[7] The improvement made in design of chair can not only reduce the problem that have been direction less before, but also provide comfort for the workers and users. Many of engineering designs can be improved due to the development of the engineering and technology. The improvement of design reduces the problem that has been

unsettled before, but also considers the condition of both workers and the environment. Chair is one of the inventions created by human for them to sit. [8]

Ergonomics is about matching equipment to the workers and the task of the worker. Another similar term used for this ergonomics is human factors. To apply ergonomics, it is necessary to know the human capabilities and of equal importance that what the person is trying to achieve. A fundamental issue considered in ergonomics is size of human body parts, means not only the person who is tall, short, thin or wide, also who have small hands, others with a long reach etc.[9] One could imagine that there are many different types of chairs with respect to people of different height. In its different appearance it can be humble or regal, made of traditional high-tech polymers or wood, simple in concept or highly harped with meaning. Basically, the requirements for a chair are few. It is necessary a horizontal surface at a proper distance from the ground level to support the human body while sitting. [7] A vertical surface is provided for back support. It may have arms or be armless. While these are the basic elements, but chair is more than the sum of its component parts. The psychological or cognitive relationship of chair with the user may be stronger than with any other types of furniture. The form of a chair is comprised of three factors function, material and aesthetics. Barber chairs are widely used in saloons. Space consumption by a barber chair is low in comparison to its function.[9] Hairdresser standing on a hard concrete floor for long periods puts a ton of stress through feet, knees and lower back muscles when the chair will not be ergonomically designed for the long time use.[3]For convenient result perfectly designed chair should be provided to the user so that barber will not feel any fatigue or discomfort. For the better performance the chair should be designed ergonomically. Human factors are an umbrella term for several areas of research that include human performance, design, and technology.[9] this is a profession which focuses on how people interact with procedures, products, tools and any processes likely to be met in the modern world.

II. LITERATURE SURVEY

Alexandra Melike Brintrup *et.al* [4], studied the necessity of formally bringing qualitative and quantitative criteria of ergonomic design together also provided a novel complementary design framework. In this paper three different algorithms based on the framework were developed, and tested with an ergonomic chair design problem. Parallel and multi objective approaches give the promising results in fitness. Research done by Mohd. Fahmi Bin Ismail [5], focused on the study of human factor that is the important term, that must considered while designing product like chair because the seating posture has been applied by user during learning, in the transport or even in the workstation. He developed a product that was to produce a frame of chair with adjustable flip table, with low cost considering human factor terms. Margarita Vergara *et.al* [6], studied 71% percent hairdressers reported pain in every part of the body is put at risk of injury from this job. Bending over to shampoo is a typical cause of low back pain. While cutting hair, keeping arms elevated in front of worker for long periods creates problems in the neck, arms, and back. Workers body is not designed to maintain these static postures for long time. Resulting in muscle strain, knots in the muscles, and pinched nerves cause pain, numbness and heaviness in the arms. Taylor &Francis [7] studied that there are many things that make products successful in the market areas. This paper was a inclusive tool for understanding how to develop products with special respect to additional product development. In this paper, materials selection, marketing and design

analysis in the form of a design manual are presented as a tool for the product developer. John C. Peek [8] focused on measuring changes in productivity related to ergonomic improvement. While most ergonomic studies focuses on health benefits, describes a project which uses a real-time shop floor control system to collect objective data to determine what effect if any, the use of ergonomically designed chairs is on the productivity of apparel-manufacturing employees. Scott open Shaw & Erin Taylor [9] explained that Human Factor is an umbrella term for various areas of research that include human performance, technology, and design. It is a career or profession that focused on how people interact with products, tools, procedures, and any processes probably to be come in to contact with the modem world. The areas of interest for human factors professionals includes the following: fatigue, usability, situational awareness, workload, user interface, learn ability, attention, vigilance, human performance, human reliability, control and display design, accessibility, stress, visualization of data, individual differences, safety, shift work, work in extreme environments human error, and decision making, including virtual environments according to "Human Factors in Engineering & Design " By McGraw – Hill [10].

Ask any barber what they want the most, they will most likely tell you about their problems that they want the best solution on it. Barber chairs determine the comfort of the customers as well as the workers when being worked and help the business in recalling and attracting more clients. Having a poor quality chair means you will only end up having worker who didn't feel comfortable during his working. Comfort does not necessarily mean that to buy expensive chairs, there are high quality barber chairs that are within a considerable range of price. So bye considering all problems of barbers, define a problem definition as below.

III. PROBLEM DEFINITION

Hairdressers working at hair salons suffer much neck, shoulder, low back pain and wrist pain. Also the constant standing and bending over can contribute to pain in low back and knees as well. Standing on a hard concrete floor for long duration puts a more stress through feet, knees and lower back muscles. Your knee, ankle and hip joints may feel achy and stiff and hence to avoid these problems, in this project we focus on flexible attachment to a barber chair on which hairdresser will seat as per their convenience.

3.1 Objective

1. To improve the design of chair with seating arrangement for barber (function).
2. Conduct an analysis for the new design.
3. Fabricate the frame prototype by providing seating arrangement.

This will enable to understand the process of engineering design in making a product and improvements in design of the chair especially for barber's need.

IV. FINDINGS AND ANALYSIS

The study focuses on the workers of different saloons where they work; they have used the barber chair previously made. The aim of this study is to find out the problems faced by the barbers or hairdressers. So, for achieving this goal a survey was conducted on 100 users using the barber chair that was previously made. Most of the workers were taken from the different saloons of different areas. The majority of them were male

workers. Their weight and age ranged from 55 kg to 120 kg and 23 years to 50 years respectively. The data has been gathered by questionnaires. Every questionnaire was taken from the barbers after working on the previously made barber chair for at least seven hours at a stretch.

4.1 Assessment of average time spent on a barber chair

Various type of pain felt by the workers while working on a barber chair depends largely on the time spent by the worker on the barber chair. The data about the average time spent by a worker on a barber chair is processed and tabulated in table.

Table 1. Average time spent by barber on chair

X	4 hr	5 hr	6 hr	7 hr	8 hr	9 hr	10 hr.	11 hr.	12 hr.	13 hr.	14 hr.	15 hr.	16 hr.
Y	2	0	11	8	7	10	15	13	14	9	6	4	1

X-Time spent by worker on barber chair

Y- No. of workers

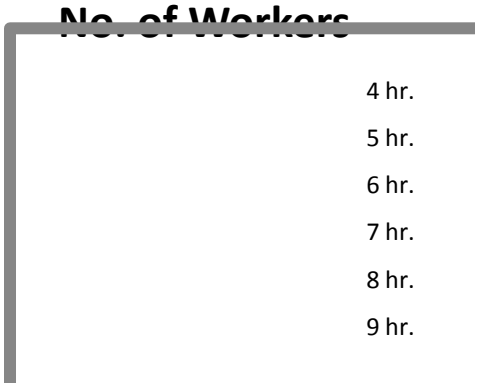


Fig. 1: Pie chart of average time spent on a barber chair

While considering the factors of average times spent by barber on chair, it is observed that most of the barber spent approximately 6 hrs while working shown in fig. 1.

4.2 Assessment of frequency of pain felt by the barbers

This survey assesses the pain felt by the barbers while they are working on the existing Barber's chair. After processing the data, it is observed that 2 workers felt no pain, 31 workers felt pain sometimes and 67 workers always felt pain as shown in table 2.

Table 2: Assessment of frequency of pain felt by the barbers

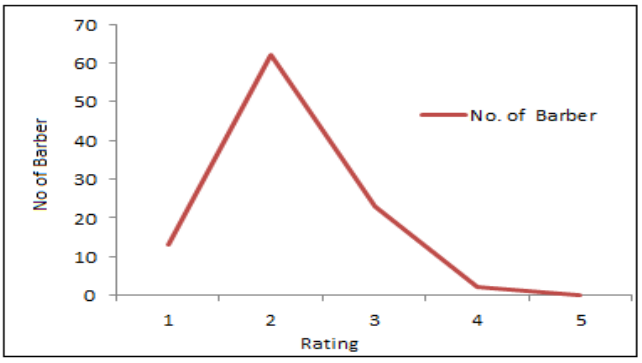
Duration spend by Barber	Never	Sometime	Always
No. of Barber	02	31	67

4.3 Assessment of comfort ability of the existing designed chair

To find out the comfort ability of the existing designed chair a scale from 1 to 5 was selected, which defines very bad, bad, good, very good, excellent respectively

Table 3: Assessment of comfort ability of the existing designed chair

Rating	1	2	3	4	5
No. of user	5	63	23	6	3



Graph 1. Rating vs. no. of barber

From above table it is shown that 63 out of 100 barbers felt uncomfortable while working on existing designed barber chair.

4.4 Assessment of pain on body while working on barber chair

This survey assesses the pain felt by the workers while they were working on the existing barber. After processing the data it is seen that 6 users felt no pain, 35 users felt pain sometimes and 59 users always felt pain shown in table 4.

Table 4: Assessment of pain on body while working

Frequency	Never	Sometime	Always
No. of user	06	35	59

4.5 Assessment of health problems faced by barbers

Hairdressers suffer a huge amount of work related injuries. A recent study showed numbers of hairdressers reported pain currently. Almost every part of the body is put at risk of injury due this job.

- Standing on a hard concrete floor for long periods puts excessive stress through feet, knees, and back. Lower body problems run from achy joints to varicose veins.
- Bending over to shampoo is a typical cause of low back pain

- When cutting hair, keeping arms elevated in front of worker for long periods creates problems in the neck, arms, and back. Workers body is not designed to maintain these static postures for long periods. Resulting in muscle strain, knots in the muscles, and pinched nerves cause pain, numbness, tingling, and heaviness in the arms.

Table 5: Assessment of health problems faced by barbers

Problems	Population	Cause
Shoulder pain	11	Working with upper arm elevated
Neck pain	7	Working with upper arm elevated and Static postures
Elbow pain	6	Improper tab height & size
Wrist pain	5	Improper tab height & size
Back pain	13	Constant standing and Frequently bending
Lower Back pain	18	Constant standing, Frequently bending and Static postures
Posture pain	12	Static postures and awkward body poisons and repetitive motions
Thigh pain	8	Working with upper arm elevated and Static postures
Knee pain	18	Standing on a hard concrete floor

V. FINITE ELEMENT MODEL DESCRIPTION

For this study, model is created using CREO parameter 2.0 version to represent a barber chair frame including modules or number of different units that mate together to form the whole frame. It includes number of components that are sized to form a frame that is custom shaped for a specific required sized chair frame. The material used for this attachment is mild steel [1] Material properties are based on cost per unit property and digital logic methods and includes Young's modulus E=210Gpa, Poisson's ratio μ=0.303, density ρ= 7800kg/m^3 [1]. Load cases analysed include vertical load through seat 120 kg (1177.2N) that is weight of worker.

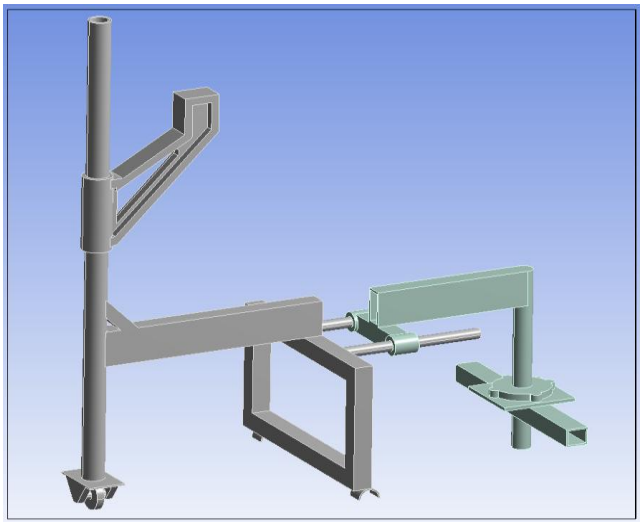


Fig.2. Creo model of barber frame attachment

Above figure 2 Shows Creo model assembly of attachment to the barber chair. Load case was analysed on a single frame geometry and then deformation and stresses evolved on attachment. For a model formation the input parameter of frame are shown in table 6.

Table 6-Model input parameters of frame

Sr. No.	Specification	Value (mm)
1	Existing Chair cylinder diameter	60
2	Height of seat pan from ground of existing chair	550
3	Horizontal bar	40*40
4	Length of horizontal bar	550-600
5	Thickness of all pipe	3
6	Diameter of vertical stool bar	50
7	Height of vertical stool bar	900
8	Caster wheels	STD.
9	Bearing	6015

VI. BOUNDARY AND LOADING CONDITIONS

For finite element analysis of the frame, the weight of worker and self-weight of attached frame were considered as loads on the frame. The boundary conditions and load applied on frame are shown in fig 3.

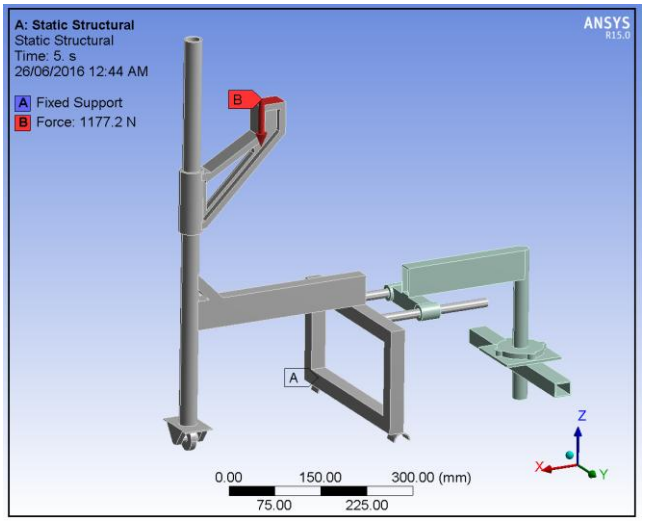


Fig.3. Loads and boundary conditions on barber chair attachment.

VII. RESULTS AND DISCUSSIONS

Fig. 4 shows deformation plot of frame under vertical loading. From fig. 4 it is concluded that maximum deformation occurred on vertical pipe because of load applied 1177.2 N is of maximum that is 1.0669mm. Here, only deformation of the vertical pipe is shown because it gives maximum deformation values.

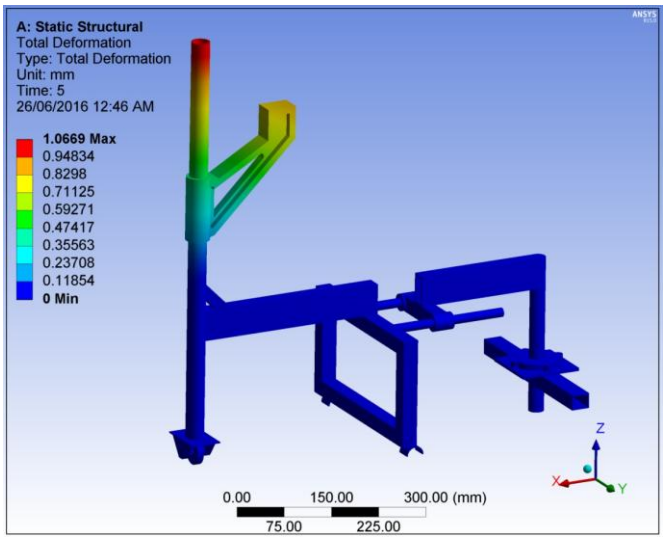


Fig.4. Total deformation of barber chair attachment

Fig.5 shows equivalent Von mises stresses produced in assembly. Stresses are maximal at joints due to change in cross sections at caster wheel and minimum at head pipe.

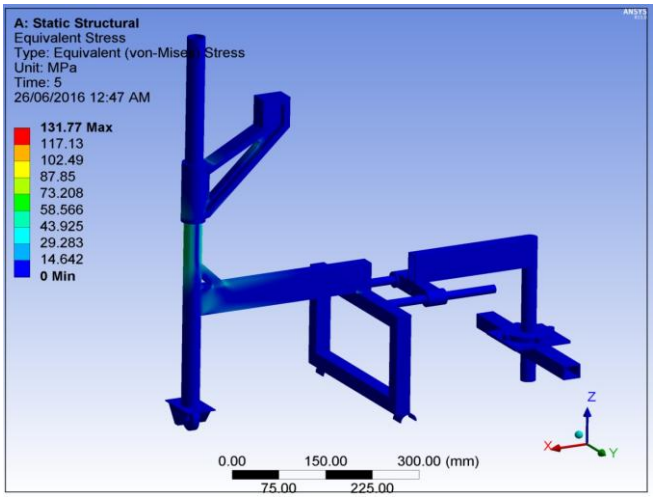


Fig.5. Equivalent Von mises Stresses

VIII. CONCLUSIONS

From the foregoing study, following conclusions emerge,

1. Seating area for barber chair can withstand the considered maximum load of 120 kg.
2. The maximum stresses are found in vertical channel which are very less (131.77MPa.) as compared to yield strength of the material due to the caster wheel arrangement.
3. The maximum deformation occurs at upper and lower end of vertical channel is 1.0669 mm which is negligible.
4. This study has given a direction to the approach to think about flexible seating arrangement provided to the barber chair.
5. Implementation of such seating arrangement to Baber's chair will definitely reduce the health problem of the barbers.

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