Design of Bicycle for Indian Children Focusing on Aesthetic and Ergonomics

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Abstract

A bicycle is a pedal driven, human-powered vehicle with two wheels attached to a frame, one behind the other. Bicycle is a mode of transportation. It is a good exercise machine. We can use it to move around or get good exercise. Completely we can say it is a good source of exercise.

In the current project, effort has been made to understand the product and its market following this the product trends are studied. By market survey, user requirements reflected various needs in the product. The different product of various brands were studied and benchmarked. After benchmarking process problem identification was done and ergonomic issues of users in user environment were studied.

The users interaction with the product, GEMBA, quality function deployment (QFD) table were made for benchmarking. Considering all important parameters, product design specification (PDS) was formulated. Concepts were generated using themeboard of the users products. Metaphors from nature and sportiveness were considered to get design inputs. Concepts were selected and finalised from the generated concepts by Pugh's chart. The final concept was modeled in 3D using PROE, Photoshop, and ALIAS Studio Tools. For the final product appearance model was made using MDF media. The modifications to improve aesthetic of the bicycle and ergonomics are represented and discussed in the paper.

Keywords: Bicycle, Human, Ergonomics, Form.

1. INTRODUCTION

Bi-two, cycle-round this makes the bike what it is. Bicycle plays an important role in transportation. Many of the people rely on or choose the bicycle for their main or only mode of transportation. Bicycle can move considerable numbers of people, especially in urban areas.

Germany's Baron von Drais invented the Draisienne, a steerable bicycle. It was almost completely made of wood, and having no pedals, riders propelled it by pushing their feet against the ground Fig 1 (1). At the time, the speed record for this bicycle was 15 km/h [1]. The Macmillan velocipede was the first of its kind to be ridden with the legs off the ground Fig 1 (2). In 1879, an Englishman by the name of Harry John Lawson produced the first bicycle driven by a chain to the rear wheel. He positioned the pedals in between the front and rear wheels, and had the pedaling motion conducted to the rear wheel via a chain as shown in Fig 1 (3). John Kemp Starley, a nephew of James Starley [2], the man who built the Ariel in 1870 and subsequently designed a number of safety bicycles, built the Rover with equal-sized wheels. This bicycle improved the performance of racing ordinaries, which had reached their limit in the quest for speed in 1884 as shown in Fig 1(4). Fig 1 (5) this is the safety bicycle produce at the Miyata Gun Factory in 1892 by Eisuke Miyata, a gun expert employed by the Hitachi Kuni Kasama Clan. Eisuke, who held doubts concerning the future of gun manufacturing in Japan, trial manufactured Japan's first safety bicycle in 1892 [3]. Fig 1 (6) this is the Japanese mini bicycle said to have appeared around 1965 due to the influence of the English Moulton. Its one-piece frame makes it easy to ride and less expensive. These factors helped stir up demand among woman.
Bicycles can be categorized in different ways: e.g. by function, by number of riders, by general construction, by gearing or by means of propulsion [6]. The most common types are, Utility bicycle - are designed for commuting, shopping and running errands. They employ middle or heavy weight frames and tires, internal hub gearing, and a variety of helpful accessories. The riding position is usually upright. Mountain bicycle – are designed for off road cycling and include other sub types of road bicycles. All mountain bicycle feature sturdy, highly durable frames and wheels, wide gauge threaded tires. Racing bicycles – are designed for speed and include road, time, trial and track bicycles. They have light weight frames and components with minimal accessories, dropped handle bars to allow for an aerodynamic riding position [7].

The bicycles are generally made up of steel. The materials used plays very important role in weight. Fork, frame and some parts are made-up of different materials. For less weight some advanced composite materials are being used. In shockless forks the material of fork can noticeably affect the feel of the bicycle, with aluminum offering the stiffest ride. Carbon fiber forks are popular in road bicycles because they are light, and also because they lessen the stiffness and absorb vibrations [8]. The tubes of the frame have been made of steel. While steel is still used. New frames can be made from aluminum alloys and carbon fiber

2. MARKET ANALYSIS

Problem Statement-“To design a bicycle for Indian children of age group 8 to 14 years considering aesthetics and ergonomics in Indian condition” [9]. Methodology:
The steps shown in Fig 2. Briefly describe the methodology used for the design of this product.

Methodology

| Product and market study | User study | QFD | PDS | Concept generation | Concept selection |

Fig 2. Methodology Chart

The targeted segments are middle class and higher middle class people. In existing market there are many branded bicycle companies, which are having different styled bicycles according to their target customers. In market main bicycle sellers are BSA, Avon, Hercules, Hamilton, Hero cycles and Atlas. From market analysis benchmarking has been done for which the important specifications of the unisex bicycles were taken into account.

According to market survey Hero cycles are having the maximum sale. So datum product was Hero cycles for benchmark. The target customers are Children (8-14yrs). Product is targeted to middle class family and higher middle class family. Fig 3.

3. USER STUDY

The user study gives detail information about the product features. In brief user study means, “Go to their environment and actually observe the customers using the product”. It is also referred as “going to Gemba”. In user study some questionnaires were prepared to take customer voice into account. In user study the quality function deployment (QFD) process was followed. QFD focuses for identification of customer needs, identifying how the good/service will satisfy customers wants, developing the importance ratings, evaluating competing products and converting the customers voice into technical voice. The important issues addressed by customers in QFD are shown in fig 4.

User

| Open chain sprocket |
| Need big carrier for bag |
| Resolve handle grip problem |

Fig 4. User Needs (QFD)

3. 1 Problem Identification

In user study the user environments were observed and identification of problems and ergonomic issues were carried on. Some the identified issues were, Back carrier is too small to carry the bags properly, the height of the handle and saddle is not proper, so by this they will get back-pain and can’t ride for longer distance. The some of the problems are shown in the Fig 5.

While resolving the ergonomic issues the Indian Anthropometric standard dimensions were considered.
The average Indian height of 50th percentile was the maximum for the age group selected, so below the 50th percentile that is 25th percentile body dimensions were considered for 8-14 year category. [10]

4. PRODUCT DESIGN SPECIFICATIONS (PDS)

Product design specification gives the specifications of the product. Specifications are as shown in Table 1,

| Performance                  | Traveling on a bicycle at low to medium speeds of around 10-15 mph (16-24 km/h). |
|------------------------------|---------------------------------------------------------------------------------
| Environment                  | It is applicable in all environments. 0-45 degree.                               |
| Manufacture                  | It is for mass production. Tooling is needed to support for manufacturing.      |
| Aesthetic aspect             | For aesthetic appealing these are considered Metaphor – (speed and rigid) Theme board – pleasing color. |
| Product cost                 | Total cost of the product is 4000/-                                           |
| Customer                     | Customer requirements are ergonomic handle, wider carrier and good look.         |
| Size and weight              | Wheel specifications: Spoke color- steel. Spoke – 22” 900210- Type. Rim specifications Diameter- 22” |
| Material                     | super light 3k carbon rim with aluminum                                         |

Table 1: Product Design Specification

The theme board was proposed keeping in perspective customers color choice. It was directed to derive aesthetic appeal and identify pleasing color. The current market trend theme board is shown in Fig 6.

5. CONCEPT GENERATION

Considering the important factors highlighted, from studies, concepts generations was done. Further working on metaphors from nature the concepts were iterated as shown in Fig 7. [11] effort was made so that by seeing the product it should feel like it is ready to run.
The material mainly used for these bicycles would be aluminum alloy frame tube. The tires would be from rubber material, rest of the parts were proposed to be made up of standard materials. The aluminum alloy weight makes the material makes light. Fork and stem is proposed to be made up of carbon fiber material.

Considering the all-sportive look the following concepts were done as shown in Fig 8.

5.1 Materials and Manufacturing Process

Carbon fiber plastic material is a composite material and is non-metallic, commonly used for aesthetic look of the products. It is much lighter in weight; it is very stiff and absorbs vibrations. Chromoly is a high strength steel alloy. It can be made into lightweight tubing with very thin wall gauges. The center frame is proposed to be made up of chromoly. Rests of the things would be made with ordinary steel. The brief manufacturing processes are tig welding, molding and press tooling which plays a very important role in manufacturing.

5.2 Rendered Concepts

The concepts were further rendered using Photoshop to get the feel of actual product. Fig 9 & 10. It gives an insight for how the actual product would look like in proposed material with actual scale, colour and light conditions. The concept frames were proposed to be made up with chromoly material, which is very light and has good strength.

5.3 Final Concept Selection and Renderings

Using Pugh’s method the final concept was selected and the output included some prime features in the product, which is mentioned in Fig. 11.

The final concept illustrated in Fig 12 is having sportive rear mudguard, electronic bell, racing speedometer (optional) ergonomically designed handle, broader back carrier and self-adjustment saddle. For reducing the weight of the bicycle the chromoly composite materials is used. Using gestalt principle the electronic bell, front and back mudguard and gear shifters are positioned. In this bicycle the side stand has been made adjustable to stand on irregular surfaces. The both boy and girl could use single bicycle thus proposed. This is totally unisex bicycle. Considering all ergonomic issues of children the bicycle was modified. The concept was inspired from the slide metaphor. Fig 12.
Major specifications of the final concept are as follows.

- Similarity
- Continuance

In Fig 13 the final concept rendering has been shown to understand the final product finish. This is having every detail to understand the parts. To solve the ergonomic issues ergonomic standards from the Indian Anthropometric dimensions were used. The target customer is 25th percentile of the Indian anthropometric standard.

The overall dimensions and orthogonal views of the final concept have been shown in Fig 15. To validate the final design a working scaled model of the final concept has been done. Fig 16.
6. CONCLUSIONS

From the above study we can conclude that aesthetic parameters leave a good impact and can lead to change in people's mindset about the product. It also gives the product a new look. Further weight and cost enhances the value of the product.

REFERENCES