8/7/2023

Bicycle Project Report

MANUFACTURING SCIENCE AND TECHNOLOGY

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Summary

This educational case study delves into the realm of material science as it pertains to bicycle wheels, frames, components, and helmets. The primary objective of this case study is to enhance both the reader's and the author's understanding of the subject. The approach involves a comprehensive exploration of material properties, structural considerations, and related factors through an analysis of literature, thoughtful discussions, practical applications, and a systematic process of material selection.

The focal point of our material selection process is directed at developing an economical, standard touring road bicycle that falls within the mid-level range. This particular bicycle is tailored to cater to the needs of intermediate to advanced road cyclists, with a keen emphasis on critical attributes such as weight and affordability. While the cost aspect will be briefly addressed, we acknowledge its complexity due to additional considerations like manufacturing intricacies, design factors, and material processing expenses.

Our envisioned cyclist profile encompasses individuals who are enthusiastic about incorporating cycling into their fitness routine, primarily using road bicycles for commuting purposes. Through a meticulous analysis of the interplay between material attributes and their suitability for specific applications, we aim to establish a comprehensive understanding of material-application correlations. The culmination of this study will present a coherent discourse on the material selection process, supported by well-defined conclusions and a glimpse into potential future advancements.

It's important to note that all the information presented throughout this study will be presented in a manner that is comprehensible to audiences without a technical background.

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Background

Bicycles serve as a widely used mode of transportation in rural regions, particularly among low-income communities. However, their popularity is also on the rise in urban areas, especially among the more privileged. Within the Indian bicycle industry, various types of bicycles such as roadsters, trendy models, and those designed for teenagers coexist. These encompass a range of options including mountain bikes, sports bikes, hybrid bikes, touring bikes, and other motorized variants. This article presents a comprehensive evaluation of India's bicycle industry, delving deeply into its dynamics. The main goal is to analyze the expansion and challenges faced by the Bicycle Industry while examining the key factors that have contributed to its growth.

Project Description

A bicycle is a human-powered, pedal-driven vehicle with a single-track design, featuring a frame and two wheels, one positioned behind the other. The person riding a bicycle is referred to as a cyclist or bicyclist. The origins of bicycles trace back to the 19th century in Europe. Remarkably, over a billion bicycles have been manufactured globally as of 2003, surpassing the number of automobiles produced. Bicycles serve as a primary mode of transportation in numerous regions and are a popular choice for recreation. Their versatility extends to applications such as children's toys, fitness, military and police use, courier services, and competitive bicycle racing.

Bicycles, one of the earliest transportation forms, continue to see widespread daily use, aiding people in their commutes to work, school, universities, and various destinations. From childhood, cycling is encouraged due to its simplicity in promoting fitness and well-being, while also contributing positively to environmental preservation. Bicycles consist of straightforward components, and the market offers various types tailored to diverse cycling experiences.

The utility of bicycles extends to transportation, bicycle commuting, and practical cycling purposes. They can even serve as reliable workhorses for mail carriers, paramedics, police officers, messengers, and delivery services. Given their multifaceted nature, bicycles present a promising entrepreneurial investment opportunity.

Here is a list of some key players in the Indian bicycle industry:

- Atlas Cycles (Haryana) Ltd.
- Atlas Cycles (Malanpur) Ltd.
- Atlas Cycles (Sahibabad) Ltd.
- Atlas Cycles (Sonipat) Ltd.
- Avon Cycles Ltd.
- Cycle Corporation of India Ltd.
- Hamilton Industries Pvt. Ltd.
- Hero Cycles Ltd.
- Metro Exporters Pvt. Ltd.

- Milton Cycle Inds. Ltd.
- National Bicycle Corps. Of India Ltd.
- Tube Investments of India Ltd.

Brainstorming and innovations

Design Thinking is a process of creating new and innovative ideas and solving problems.

The process involves five key components:

1. Empathize: Gaining a profound and personal grasp of the problem at hand is crucial.
2. Define: The subsequent step is to articulate the problem by formulating a problem statement, informed by insights from the preceding stage.
3. Ideate: Designers engage in brainstorming to generate a range of ideas, aiming for innovative solutions aligned with the defined problem statement.
4. Prototype: The design team creates scaled-down, cost-effective product versions, which are then shared and tested within the team.
5. Test: Meticulous testing of the final product is carried out, incorporating the optimal solutions identified during the prototyping phase.

Design

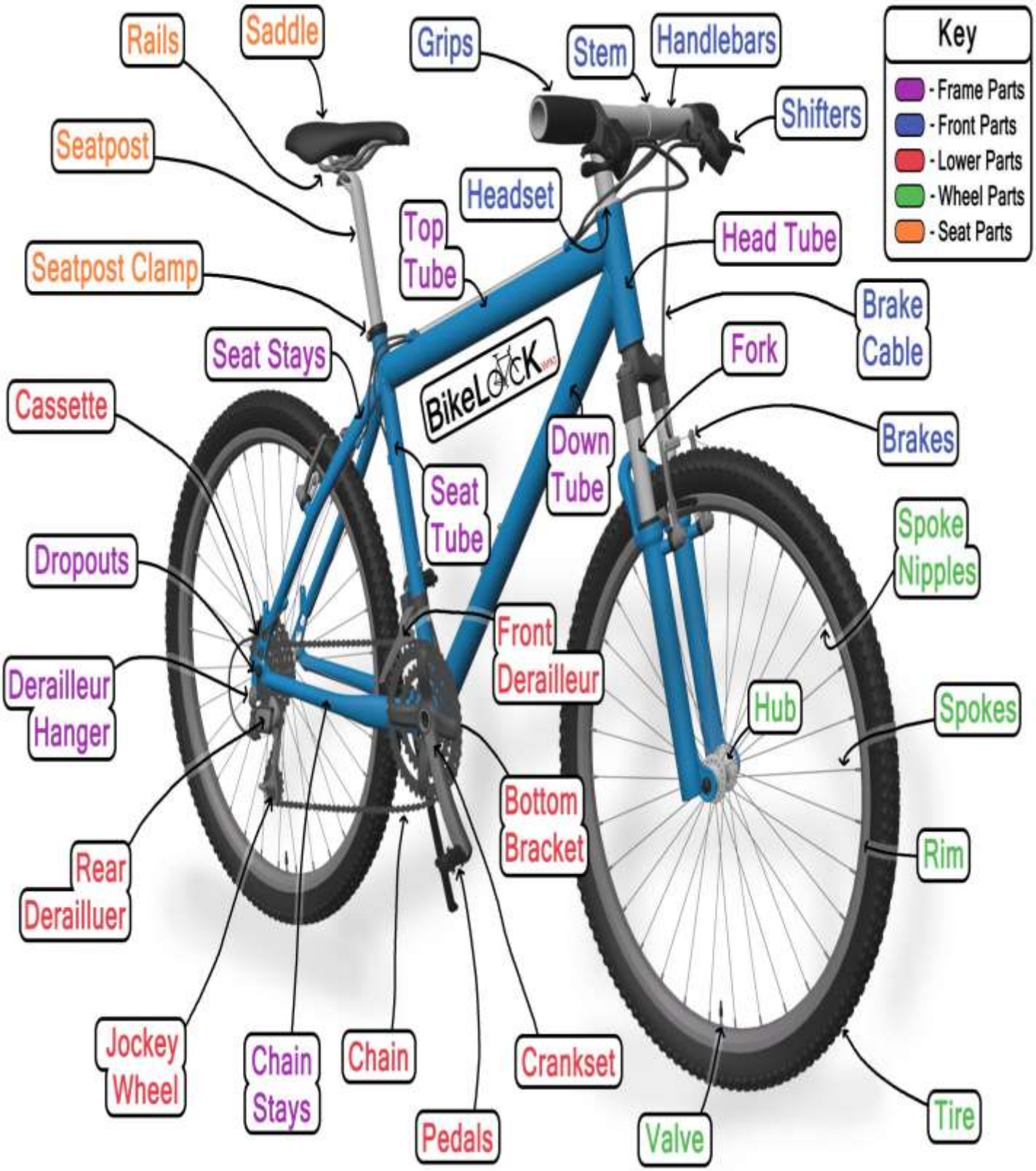
The pivotal element of a bicycle is its diamond-shaped frame, which serves as the foundational link connecting all its components in the correct geometric arrangement. This frame imparts both robustness and stiffness to the bicycle, significantly influencing its handling characteristics. Comprising the frame are the front and rear triangles, with the front forming more of a four-sided figure created by the top, seat, down, and head tubes. The rear triangle encompasses the chain stays, seat stays, and rear wheel dropouts. At the front of the frame, the fork and steering tube are attached to the head tube.

Throughout a substantial portion of the bicycle's history, the frame was crafted from sturdy yet weighty materials like steel and alloy steel. Ongoing advancements in frame materials aimed to enhance attributes such as strength, rigidity, lightness, and durability. The 1970s ushered in a new era of more versatile alloy steels, amenable to mechanical welding, thereby increasing the availability of lightweight and cost-effective frames. In the subsequent decade, lightweight aluminum frames gained popularity. Notwithstanding, steel and titanium remain the sturdiest metals, boasting longevity spanning decades, while aluminum might exhibit fatigue within a span of three to five years.

By the 1990s, technological progress facilitated the adoption of even lighter and more robust frames composed of composites, which combine structural fibers like carbon. Unlike metals, composite materials exhibit anisotropic properties, showcasing maximum strength along the fiber axis. This

characteristic allows composites to be shaped into integral frame pieces, strategically reinforcing areas that require strength.

Components such as wheels, derailleurs, brakes, and chains are typically fashioned from stainless steel. These components are typically sourced externally and procured by bicycle manufacturers.



Material Selection

Mainly 4 types of material is used in manufacturing of bicycles depending upon budget Segment of Customers-

1. Hard Tensile Steel (Steel with Strong Tensile Properties)

- Cost-effective Material with Straightforward Manufacturing
- Simplicity in Repair and Maintenance
- Typically Found in Bicycles Priced Below 10k
- Durable Material for Handling High Stress
- Susceptible to Road Vibrations (Increased Impact from Uneven Surfaces)
- Prone to Corrosion and Rust Formation

2. Aluminium

- Aluminium boasts significantly lower density compared to steel.
- Reduced Density (Resulting in reduced impact sensation for cyclists when traversing uneven terrains.)
- Lower Density (Leading to efficient power transmission from pedals to the road surface.)
- An increase in thickness contributes to heightened frame stiffness while marginally reducing rigidity. This material is commonly employed in bicycles within the 20k to 80k price range.
- Greater longevity compared to carbon alternatives. Aluminium's designated material code is 6061.
- Aluminium 6061 stands as a precipitation-hardened alloy, characterized by the presence of key alloying elements - magnesium and silicon.

3. Carbon Fiber

- Highly adaptable for shaping and molding into various forms.
- Offers reduced road shocks and vibrations for cyclists.
- Found in premium bicycles (ranging from 1 lakh to 3 lakhs in cost).
- Susceptible to wear and damage in case of crashes.
- Capable of being crafted into streamlined aerodynamic tube designs.

4. Titanium

- Lower density compared to steel, enabling lighter framesets.
- Resistant to corrosion, ensuring longevity.
- No requirement for paint, minimizing concerns about scratches and chips.
- Exhibits strength, durability, and resistance to fatigue.
- Slightly heavier than carbon or premium aluminium.
- Considered costly.

Ultimately, the choice was made in Favor of Aluminium Material due to its extensive range of attributes.

Manufacturing Process

Seamless frame tubes are crafted from solid blocks of steel, initially pierced and then progressively "drawn" into tubes through multiple stages. This technique typically yields tubes of higher quality compared to seamed tubes, which involve flat steel strips drawn into a tube shape and subsequently welded along the tube's length. Seamless tubes can undergo further refinement to enhance strength and reduce weight through a process known as butting. This method involves strategically altering the thickness of the tube walls, reinforcing them at stress-prone junctions (ends of the tube) while thinning them at low-stress central sections. Butting not only strengthens the frame but also enhances its flexibility.

Butted tubes come in different variations:

- Single-butted: Thicker at one end.
- Double-butted: Both ends are thicker than the center.
- Triple-butted: Varying thicknesses at each end.
- Quad-butted: Similar to triple-butted, with thinning toward the middle.

Nonetheless, constant thickness tubes remain suitable for specific bicycle types.

The assembly of these tubes forms the frame, achieved either through manual brazing or machine welding. The former is a labour-intensive process and hence carries a higher cost. Composites, on the other hand, can be bonded using robust adhesives or plastic binders. Components, generally machine-manufactured, are then attached to the frame manually or by machines. A final skilled touch from experienced bicycle builders ensures precise adjustments before completion.

BI-CYCLE SPECIFICATIONS

- **Tire Size: ** 26 inches
- **Frame Size: ** 18 inches
- **Cyclist Height Range: ** 5 feet 1 inch to 6 feet 0 inch
- **Frame Material: ** Carbon Steel
- **Suspension: ** Rigid
- **Dimensions (L*W*H): ** Approximately 142 x 20 x 72 centimetres
- **Item Weight: ** Approximately 17-19 kg
- **Brake Type: ** Linear Pull, Disc

Cost Analysis

Items	Cost
Handle Bar	400
Frame	7500
Fork	750
Crank Set	700
Wheel Rim	1500
Spokes	500
Hub	400
Sprocket	500
Free Wheel	550
Chain Assembly	750
Tire	1000
Seat Assembly	700
Brake operating lever	700
Brake Cable	1400
Brake Calipers	300
Guards	500
Pedal	200
Saddle	1000
Center Shocker	800
Other cost	800
Total Cost	20250

Conclusion and Future Prospects

During the final decade of the 19th century, a significant proportion—approximately one-third—of fresh patent submissions directed to the U.S. Patent Office pertained to innovations related to bicycles. Over the course of the 20th century, the technical and material advancements in bicycle design, at times, outpaced even those seen in automobile engineering. As we transitioned into the 21st century, it becomes evident that even bicycles traditionally considered "low-class" or inexpensive are now pushing the boundaries of lightweight construction, efficiency, functionality, and cyclist-oriented high performance.

In summation, the trajectory of bicycles appears promising due to their progressively growing popularity for diverse applications. This burgeoning trend underscores the pivotal role of material choices and design innovations in shaping the future of this technology. Additionally, the environmentally friendly attributes of bicycles have further fuelled their current widespread use, offering an alternative to automobiles for commuting. However, the driving force behind this popularity remains rooted in the practicality of cost-effective exercise and transportation.

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We are very grateful to Mr. Sant Ram Chauhan who gave us a chance to work on this project. We would like to thank him for giving us valuable suggestions and ideas.