

Conceptual Design of Quad Bike for Urban Commuting

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Abstract

In Indian market two wheelers dominate the sales chart owing to their quick commuting means and affordability. Even though two wheelers are convenient for urban commuting, they come with their own shortcoming. The fatality rates associated with two wheelers are very high and the ergonomics of two wheelers are not on par with four wheelers. These two factors have led to the rise in single driven cars which contribute to rise in traffic congestion and also price per person for commuting. The above phenomenon parts way for a new segment in urban commuting namely Quad bike. Quad bikes are around since the early 19th century where in they are built for off road activities. Quad bikes which are being designed for urban commuting are only a decade old consisting of a handful of manufacturers and there are none in the Indian market. This paves way for exploration of new ideas.

The present project focuses on the conceptual design of Quad bike for urban commuting to improve safety as well as aesthetic aspects in its development with an objective to run by an electric drive, to suite wide-user range, to provide ample storage space and also with unisex design elements for Indian customers. To identify the design parameters the above said objectives were achieved through survey and Gemba study. Target customers were selected based on the survey results with this reference. Quality function deployment (QFD) and Product design specifications (PDS) were developed based on their requirement. Concept sketches were developed using hand and digital media based on the doodle sketches. Non parametric modeling and rendering of the final concept were carried out followed by building a 1:5 scaled down mockup model for better visualization with all necessary details. Ergonomic analysis was carried out virtually to suite wide range of user group.

In the end Quad bike was designed which incorporates an active lean suspension, contemporary design features, comfortable ergonomics for both 50th and 90th percentile users and storage space, in context with the Indian market.

Key Words: Urban Commuting, Aesthetic, Ergonomics, Design Elements, Contemporary Design

1. INTRODUCTION

Ever since the dawn of automobiles in the early 19th century, cars and motorbikes have been the only means of personalized mobility. Automobiles have changed how people commute from point 'A' to point 'B'. Over the years owing to many technological innovations automobiles are at its pinnacle state and vast ground breaking ideas have lead to innovative products in huge numbers.

The growth of automobiles has contributed to the betterment of lives but also sadly to the downfall of it too. In the modern metropolis traffic congestion is at its maximum leading to increased commuting time and soaring fuel prices. In a survey conducted, during car usage, only one seat is occupied almost 75 % of the time [1]. This leads to wasted assets in terms of road space and price per person of commuting. Cars are no longer as strong a status symbol as in the past. In many countries interest in cars is waning [2].

Two wheelers are useful for quick commuting as well as decongestion of roads. But it accounts for the highest share in total road accidents around 26.3% in cities according to survey done in 2013 [3]. Hence, it is no longer safer in present traffic scenario for urban commuting. When it comes to cars, safety is an unmatched asset. In Indian market two wheelers are the most preferred means of commuting. The major competitors in motor scooter sector are Honda Activa, TVS Jupiter which have wide user appeal and also rates highly on practicality for every day usage. From sales

point of view also two wheelers continue to dominate the sales chart in widely populated countries such as India, China where weather favors roofless commuting [4].

From design point of view Quad bikes meet safety as well as decongestion needs which establishes market gap. Quad-bikes are becoming more and more popular in many areas of the world for many different reasons [4]. Hence, this project is aimed at conceptually designing a Quad bike for urban commuting which is targeted for premium segment customers.

2. METHODOLOGY

Conceptual design of the product was developed by solving different objectives of the project. To successfully meet the requirements of the target customers, Gemba study was carried out for the premium segment customers keeping in mind the Indian Context. Based on the results from survey and Gemba study, Quality function Deployment (QFD), Product Design Specification (PDS) were generated which gave a set of design guide lines for the next phase of project. In the next stage, doodle sketches were generated by hand sketches and further refined in Photoshop tool. Concepts were generated based on doodle sketches. 3- 5 concepts were narrowed down out of which one was selected based on weighted ranking method. This concept is further developed via 3D modeling and rendering in Alias tool. To evaluate the design ergonomic analysis was carried out in Catia using 50th

and 90th percentile dummies. Various design iterations were carried out at this stage to refine the design to meet ergonomic criteria. Finally a 1:5 scaled down Mock up model was built using wood for visualization.

3. DESIGN/SIMULATION

In this section the design process for concept development of the quad bikes is discussed.

3.1 Data collection

Data was collected from various sources like: Bike users, face to face interviews with inspection of the user’s product (Gemba) and online surveys to know the problems of the customers.

Outcomes obtained from the survey, is as follows:

- 2 wheelers is the most preferred means for commuting
- In a car 75% of the time only 1 seat is occupied while commuting
- Safety and ergonomics issues is the main concern in 2 wheelers which demands attention
- Demand for simplicity of usage in 2 wheelers in stop and go traffic conditions
- Practicality is the most preferred aspect while buying a vehicle
- Incorporation of GPS, smart phone connectivity in 2 wheelers were preferred
- Masculine and Neutral design is most preferred in future vehicles

3.2 Product design development

Through survey the essential inputs were compiled in terms of customer and technical requirements to develop Quality Function Deployment (QFD) matrix. Table 1 shows QFD matrix for Quad bike.

Table 1. QFD Matrix

| | | |
|---------------------|--------------|---------|
| Strong Relationship | ★ | 5 |
| Medium Relationship | ● | 3 |
| Weak Relationship | ○ | 1 |
| Positive | + | |
| Negative | NIL | |
| Competitor Rating | High Weak | 10 1 |

| Customers Requirements | Technical Requirement | | | | | | | | | | Conceptual Product | Competitor A Piaggio MP3 | Yamaha Tricity | Competitor B Quadro 44 |
|----------------------------------|-----------------------|------------|-------------|--------------------|---------|----------|------------|------------|-------------------|----|--------------------|-----------------------------|-------------------|---------------------------|
| | Customer Importance | Ergonomics | Drive Train | Design / Aesthetic | Utility | Handling | Durability | Suspension | Safety Parameters | | | | | |
| 1 Ride Quality | 5 | ○ | ○ | | | | | | | ○ | ○ | ○ | ○ | |
| 2 Comfort | 5 | ★ | | | | | | | | ○ | ○ | ○ | ○ | |
| 3 Safety | 5 | ○ | | | | | ★ | | | ○ | ○ | ○ | ○ | |
| 4 Mileage | 3 | | ★ | | | | | | | ○ | ○ | ○ | ○ | |
| 5 Simplicity of usage in traffic | 5 | ★ | | | | | | | | ○ | ○ | ○ | ○ | |
| 6 Suspension | 5 | | | | | | ★ | | | ○ | ○ | ○ | ○ | |
| 7 Storage | 2 | | | | | | | | | ○ | ○ | ○ | ○ | |
| 8 Accessories | 4 | ★ | | | | | | | | ○ | ○ | ○ | ○ | |
| 9 Styling | 4 | ★ | ★ | | | | | | | ○ | ○ | ○ | ○ | |
| 10 Maintainance | 3 | | ★ | | | | | ★ | | ○ | ○ | ○ | ○ | |
| | | 155 | 45 | 89 | 80 | 88 | 27 | 75 | 82 | 82 | | | | |
| Priority | | 11 | | | | | 23 | | 23 | | | | | |
| Ranking | | | | | | | | | | 87 | 75 | 76 | 76 | |

From the QFD it is found that ergonomics aspect is highly prioritized (with 115) and followed by safety (with 82) and handling aspect (with 80). Also competitors products were analyzed and compared with the conceptual product.

3.3 Data analysis

With the inputs from the QFD and the survey Product Design Specification (PDS) was prepared. This serves as a design guideline to proceed with product development. Table 2 shows PDS requirements for the Quad bike.

Table 2. PDS for Quad bike

| Sl.No. | Factors | Specification |
|--------|----------------------------|--------------------------------|
| 1 | Overall vehicle Dimensions | 1465 mm X 783 mm X 1209 mm |
| 2 | Drive train type | Electric |
| 3 | Motortype | Twin hub motors at rear |
| 4 | Power output | 14 KW (20 BHP) |
| 5 | Battery | 60V, 120AH, li-ion battery * 2 |
| 6 | Steering | Handle type |
| 7 | Safety | Airbags, ABS |
| 8 | Suspension | Active lean suspension |

3.4 Concept Generation

For any product development process concept generation is the prime source. To generate the concept it is difficult to get new ideas, hence various visual metaphors were used during the early stages.

The visual theme board gives a mindset and a pattern of various inspirations to proceed with. Target customer being Indian urban commuters their life style was analysed which is represented in Fig. 1.



Fig. 1 Visual Theme board

It shows they are adventures, fun loving, enthusiastic, sporty and spends time in leisure activity along with their daily routine. Based on these inputs ideation sketches were generated for the Quad bikes. Fig. 2, shows first set of ideation sketches.

Fig. 3, shows second set of doodles. In this section some of radical proportions and aggressive stance was explored.

In this stage some of the doodles from the previous stages were taken forward for further refinement.



Fig. 2 Ideation/doodles 1

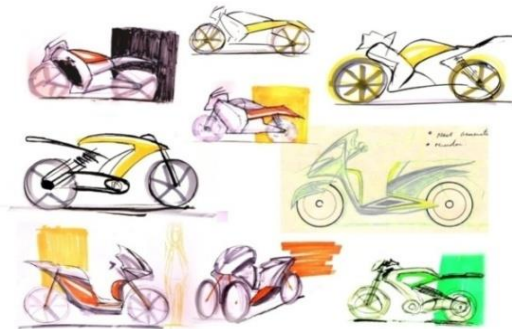


Fig. 3 Ideation/doodles 2

3.5 Concept Development

Concepts were developed using the doodles. Fig. 4 shows the 1st concept. This concept consists of simple flowing surfaces with a semi step throughout the design. It incorporated a visor for aiding long journeys in highways. The storage was in under seat while the battery pack was stored as shown in the Fig. 4. Due to its semi step through design, a wide user reach is hampered owing to Indian female customer's attire.



Fig. 4 Concept 1

Fig. 5 shows 2nd concept. This design is more feminine when compared to first concept. It featured a fully step through design, keeping in mind the female customers.



Fig. 5 Concept 2

Fig. 6 shows 3rd concept. In this concept some of the traits from the previous two concepts were combined, which gives rise to a wide user appeal. This concept balanced out the aesthetics which saw a unisex appeal. The front portions are inspired from eagle while the rear has simple surfaces. The storage was both in front compartment and also in under seat compartment.



Fig. 6 Concept 3

Fig. 7 shows 4th concept. This design featured a more radical approach. The design was inspired from boomerang as can be seen in Fig. 7. The design was not practical in terms of daily usage.



Fig. 7 Concept 4

Fig. 8 shows 5th concept. This concept was based on motorcycle proportions. The stance is aggressive appealing to younger male customers. However the concept was failed to gain the attention of female and middle aged customers.



Fig. 8 Concept 5

3.6 Geometric modeling

Modeling was carried out using Alias tool. The concept sketch was taken and using the sketch as a reference the modeling was carried out. Fig. 9, shows Alias model of final selected concept sketch.

4. RESULTS AND DISCUSSIONS

4.1 Concept Selection

Once the concepts were generated, a final concept was selected based on the weighted ranking method. Table 3 shows the weighted method

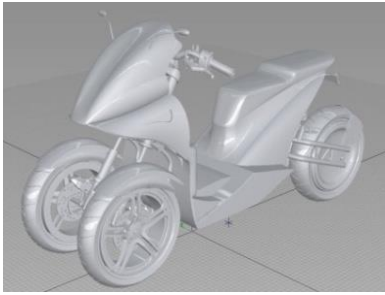


Fig. 9 Modelling using Alias tool

Table 3. Weighted ranking method

| Features | Concepts | | | | |
|------------------|-----------|-----------|-----------|-----------|-----------|
| | 1 | 2 | 3 | 4 | 5 |
| Practicality | 3 | 4 | 5 | 2 | 2 |
| Aesthetics | 3 | 4 | 4 | 5 | 5 |
| Wide user appeal | 3 | 3 | 5 | 3 | 2 |
| Ergonomics | 5 | 4 | 5 | 3 | 4 |
| Total | 14 | 15 | 19 | 13 | 13 |

Based on the weighted ranking method, concept 3 has been selected. Concept 3 has a good balance between practicality, aesthetics, wide user appeal and ergonomics aspects.

5. VALIDATION STUDIES

In this session once design is finalized virtual model is built. To validate product designed will be subjected to standard tests virtually to meet various population extreme. Physical prototype is also developed to validate aesthetic part of the design.

5.1 Ergonomic Analysis

Once the alias modeling was completed, ergonomic analysis was carried out in Catia to validate the design because riding posture could be a major problem cumulating in riding discomfort [5]. The drivers posture of the seated person with the individual tasks to be performed while riding bike has been studied and several iterations were made to refine the design. Figure 10 shows ergonomic analysis where for 50th and 90th percentile populations were compared by assigning Indian anthropometric data's [6]. Hence from the study it was found that the design is versatile which suites wide range of users.



Fig. 10 Ergonomic analysis of final concept

5.2 Mockup model

For visualization, after the rendering stage, a 1:5 scaled down mockup model has been built using wood. Mockup model was built a overall physical feel of the

product which leads to further design iterations. Fig. 12 shows mock up model. It had all the features and aesthetics applied.



Fig. 12 Mock up model of Quad bike

6. CONCLUSIONS

The designed Quad bike is a 4 wheeled vehicle (dimensioning 1465 * 783 * 1209 in mm) and is close to the two wheeler dimensions i.e., Bajaj Pulsar (1320 * 755 * 1060 in mm), but with better features for safety and handling aspects. Space occupied by the Quad bike is less when compared to a car thus leading to decongestion in roads.

The above stages of the project have led to:

- An Alternate means of transportation is conceptualized which effectively solves an existing problem
- A quad bike with better ergonomics feature is designed

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