

Engineering Design Process of Mobile Back Cover

R.S. Lavate¹, Sachin Chavan^{2,*}, M.K. Beldar³, Avishi Saini⁴

Abstract

A mobile back cover protects phone from dents and scratches if anyone accidentally drop it. Most importantly, they enable a good grip on the phone. Cases, which are designed to attach to, support, or otherwise hold a Smartphone, are popular accessories for a mobile phone. Mobile back case measures are based on the display inches (e.g. 5 inch display). Many other different types are Pouches and sleeves, holsters, shells, fitted cases, flip cases and wallets, screen protection and body films, Drop and shock protection, Leather case and Cases with integrated kick stands. Mobile covers can also personalize as per customer's needs. These are the result of the relatively "naked" designs produced by manufacturers such as Apple, where the metal and glass components of the device are exposed and vulnerable to damage. This research paper mainly deals with a detailed and in-depth study of mobile back cover from a manufacturer's point of view such that the problems related to the cover are effectively minimized and can satisfy consumers requirements and desires.

Keywords: Mobile back cover, market survey, Product architecture, modular, quality functional deployment, concept generation, aesthetic, ergonomics, design for manufacturing, design for environment, product life cycle

INTRODUCTION

The mobile cases and covers market is highly influenced by evolving lifestyle trends and increasing spending capacities of consumers. To ensure a long shelf life of smart phones, consumers are using protective cases and covers. Increasing demand for 360-degree surface protection for smart phones is offering significant profit earning opportunities for key players in the mobile cases and covers market. Millennial are more concerned about reducing plastic waste, hence the biodegradable mobile cases and covers market is expected to grow in the next decade. That's why it is preferred by certain portion of

the population. By print type, "with print" segment is anticipated to hold a major share in the mobile cases and covers market during the forecast period. Asia-Pacific is expected to outpace the global mobile cases and covers market in the next decade, attributable to the presence of large number of consumers. China, India, and Japan are anticipated to offer lucrative opportunities, driven by increasing production of smart phones and cost-effective mobile cases and covers [1].

A market survey is the first step before launching any product. A market survey is any organized effort to gather information about a target market or customer. It can be inferred from the case studies based on a market survey that people like to use top loading fully automatic machines in India.

*Author for Correspondence

Sachin Chavan
E-mail: sschavan@bvucpep.edu

^{1,3}Assistant Professor, Mechanical Engineering Department, Bharati Vidyapeeth (DU) College of Engineering, Pune, Maharashtra, India

²Professor, Mechanical Engineering Department, Bharati Vidyapeeth (DU) College of Engineering, Pune, Maharashtra, India

⁴Student, Mechanical Engineering Department, Bharati Vidyapeeth (DU) College of Engineering, Pune, Maharashtra, India

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Product architecture is the second step, Product architecture is the mapping of product function to the completed product form. A well-designed product encompasses well-structured product architecture, to the point where every component has a very detailed function and does not contain needless components. Reducing the number of components leads to an overall integral product. An integral product has a very high function-to-component ratio, which means that the product is able to perform many different functions using the same components in different ways [2].

There are two types of product architecture, which are as follows:

1. *Modular type of Product architecture:* In this type each implements one or few functional elements in their entirety. This is less expensive than the other as it uses standard components Here if one element fails it can be easily replaced. In the modular type, well-defined component interfaces functionally self-contain modules. Organize a product into a number of modules to develop and complete a specific function. The interaction of these modules carries out the product's overall purpose. The advantages of modular include task allocation and outsourcing. As well as, economies of scale, reuse/standardization for developing new products, maintenance, and mass customization.
2. *Integral type of Product architecture:* In this type, when we need to make a system – or a frequently used function in a system – very fast, we write it from scratch. We also structure the data used by the system in such a way that it can be processed very rapidly. This goes for both bulk performances of things like database lookups as well as quick response for simple things like mouse movements. Integration can also be used to enhance reliability and resilience. Instead of using a common error- handling routine, core functions will include their own error handling to achieve the most rational form of retrying and rebuilding data structures before giving up and failing [3].

Quality Functional Deployment

QFD is a project-development tool whose aim is to make inter functional communication between R&D, marketing and production much easier and more effective. This is achieved by linking together the clients' needs/wants and the technical aspects of the product/service which can full fill them, as well as including the respective performance of the competitors. QFD is a focused methodology for carefully listening to the voice of the customer and then effectively responding to those needs and expectations. First developed in Japan in the late 1960s as a form of cause-and-effect analysis, QFD was brought to the United States in the early 1980s. It gained its early popularity as a result of numerous successes in the automotive industry.

Concept Generation, Screening and Testing

Concept generation is a procedure that begins with a set of customer needs and target specifications and results in an array of product concept design alternatives from which a final design will be selected. This step requires a more abstract style of thinking than perhaps most engineers are used to. It is the first and the most important step in creating a great product. Product developers must probe the idea, ask the right questions and provide valuable insights that can transform mere figments of their imagination into what people will term great products. Concept Screening is a critical step in client's innovation process where we test multiple new product ideas developed in a concept board format. The objective is to understand and measure the potential of each concept in order to define the one(s) which should be further progressed in the process. Usually, the product concepts are already quite developed with some key elements: brand, insight, benefit, reason to believe. A concept testing survey helps teams evaluate product development, an ad campaign, or even a message or claim, by getting feedback from customer segments who make up the target market [4]. Whether you want to test a single concept, or compare different concepts with an A/B test, taking the time to test before you execute can help you avoid mistakes, tailor products for potential customers, and arm you with data to sell your ideas throughout your company.

Aesthetic and Ergonomics

In this step one must select few important factors that lead to the improvement of the product and differentiate them from already existing ones. Ergonomic is a scientific discipline that establishes relationship between humans and systems so that human stress can be reduced. The main aim of ergonomics is that machines should adjust as per humans. From the case study it can be inferred that the ergonomic evaluation served as preliminary assessment of potential risk factors. Suggestions should be applied immediately and with low cost to employer. Further ergonomic analysis can be performed to details specific concerns or issues [5].

Design for Assembly and Manufacturing

Is used to estimate the manufacturing cost and then further reducing cost of components, assembly, supporting mechanism and analyzing its effect on other factors. Moreover, reducing number of wires on the exterior, compliance to assembly, all some under DFMA. This increases productivity and effectiveness. From the case studies I can be inferred that applying DFMA method increases reliability and effectiveness in analyzing manufacturing process and providing answers for process and product improvement.

Design for Environment

The main aim to use DFE is to reduce carbon footprints and reduce environmental pollution as much as possible. Reducing waste, use of clean energy so that an eco- friendly and healthy environment could be generated. From the case studies it can be inferred that a washing machines with filters at outlet to reduce the toxins in water and use the water for other purposes such as gardening. With increasing urban population, using power saving technologies in washing machine along with water recycling or filtering systems is a mandatory step to take [6].

Product Life Cycle

Is the last step of product design and the term product life cycle refers to the length of time a product is introduced to consumers into the market until it's removed from the shelves. The life cycle of a product is broken into four stages:

1. Introduction
2. Growth
3. Maturity
4. Decline

This concept is used by management and by marketing professionals as a factor in deciding when it is appropriate to increase advertising, reduce prices, expand to new markets, or redesign packaging. The process of strategizing ways to continuously support and maintain a product is called product life cycle management. Working of a Product Life Cycle: Products, like people, have life cycles. A product begins with an idea, and within the confines of modern business, it isn't likely to go further until it undergoes research and development (R&D) and is found to be feasible and potentially profitable. At that point, the product is produced, marketed, and rolled out [7].

METHODOLOGY

Industrial product design is a very important and deep subject. It emphasizes practical aspects that any new business needs to do before establishing the business idea in real life. Big companies like Sony (Walkman), Hindustan Unilever (Lux), Hewlett-Packard (HP), Ford, etc do the development of their product by using this methodology.

To develop a mask from the manufacturer's point of view, the following is the process to develop it in an efficient manner that satisfies customer requirements and is capable enough to sustain itself in the market as a strong competitor.

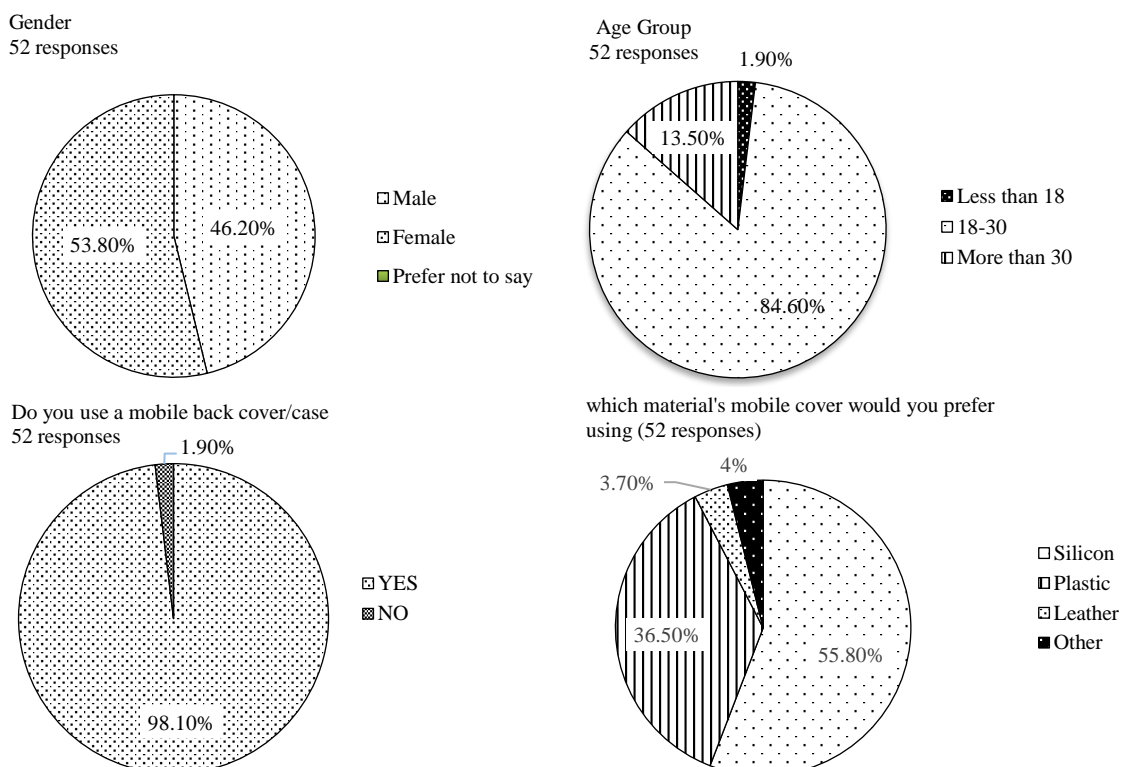
Market Survey

The most fundamental step is to do a market survey of our product. A market survey is research and analysis of the marketplace so that one could understand the market very well and the reason why one should do a market survey of a product so that one could study the issues, preferences, and buying behavior of consumers related to the product.

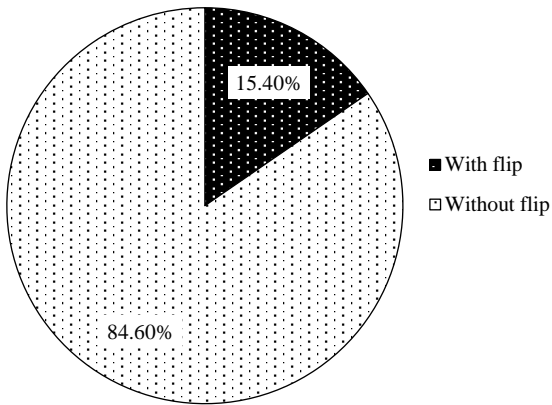
Moreover, by doing a market survey some could add innovation to the product or enhance the already existing product as per the requirements of consumers. There are various method of doing market surveys like In person surveys, telephonic surveys, Main surveys, Online surveys [8].

Benefits of Market Survey

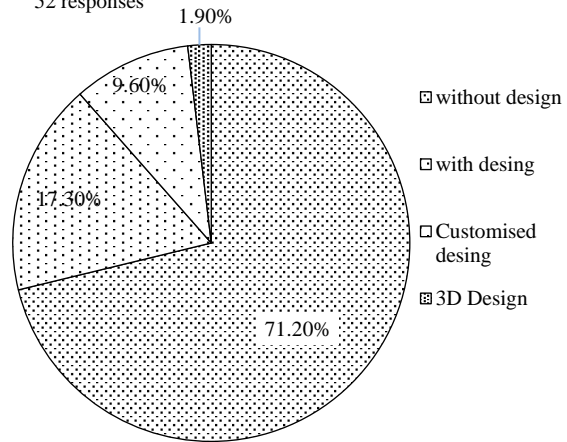
1. It helps businesses strengthen their position. Knowledge is power. Use marketing research to achieve a stronger perspective and understanding of your market or target market and make sure that your firm stays earlier than the competition.
2. It minimizes any investment risk. this is often a straightforward but vitally important and sometimes business-critical consideration. Spending what's often only a little proportion of your investment on researching and testing the market, product, concept or idea makes sound business sense.
3. It identifies potential threats and opportunities. Primary research (fieldwork) and secondary research (desk research) will be utilized as insurance against obvious dangerous the road ahead. Coupling this with some qualitative research for deeper probing can highlight certain opportunities or warning signs which will otherwise be missed (Figure 2).
4. It helps to find your and your competitor's strengths and weaknesses. It's vitally important to adopt an 'eye's wide open' approach to any marketing research project which is why it's often advised to figure with a marketing research agency to make sure completely unbiased reporting [9, 10].
5. Market survey and their responses are shown below: There were almost 15 questions and the total number of responses that were gathered was 52 (Figure 1). Some of the questions are mentioned below along with their responses.



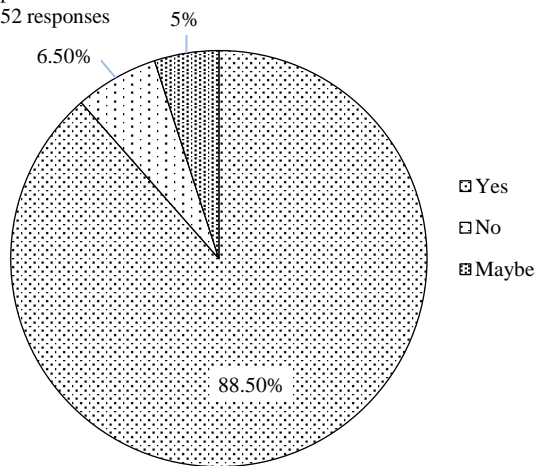
Would you like mobile cover with a flip or without a flip case?
 52 responses



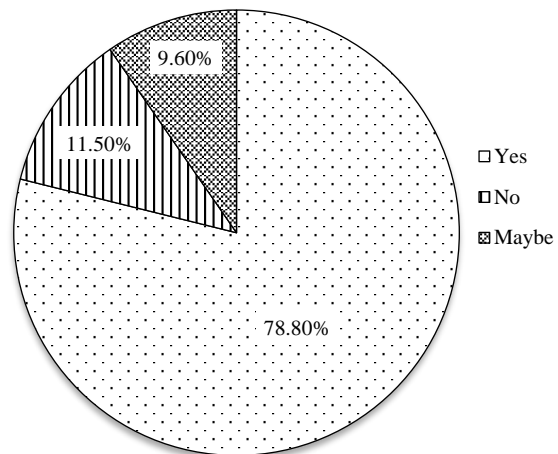
Which type of design/pattern would you prefer on you cover?
 52 responses



Would you prefer raised edges for camera protection?
 52 responses

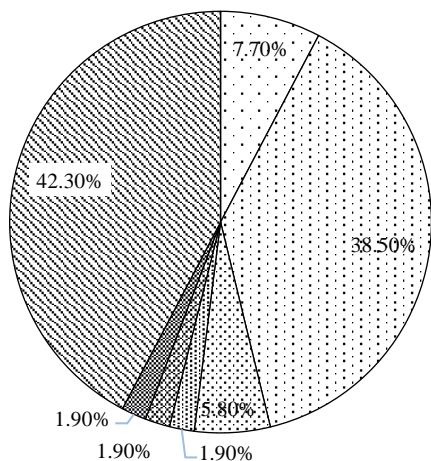


Do you want it to be light?
 52 responses



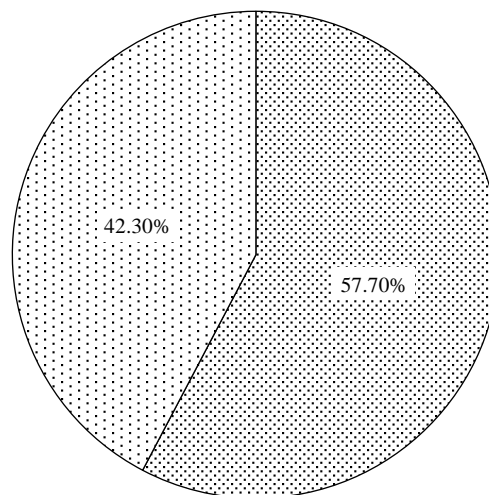
Which brand you would prefer?
 52 responses

- The GiftKart 7.7%
- Amazon brand-Solimo
- CEDO
- Chumbak
- TREEMODA
- CelfieDesign
- Memorise
- other



What is your preferred mode of purchase?
 52 responses

- Online
- Offline
- Other



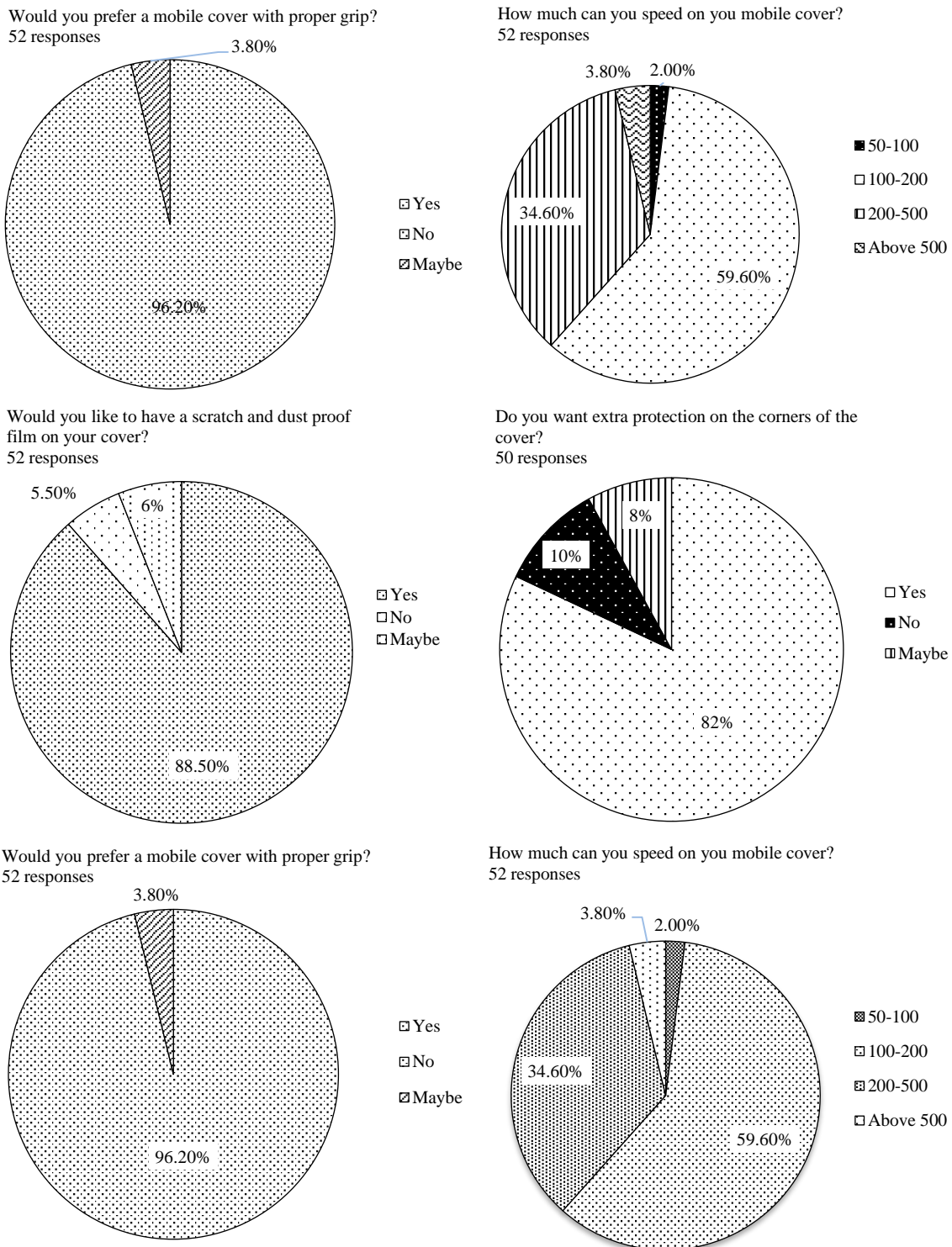


Figure 1. Market survey and their responses.

PRODUCT ARCHITECTURE

The arrangement of functional elements into physical chunks which become the building blocks for the product or family of products is product architecture. This approach is opposite to the idea of modularity, where modular products have many components that correspond to a specific function that the product fulfils. Often times, one design method is chosen over the other even though the advantages of applying either method to a certain product are not fully realized.

What is your main motive behind using a mobile cover/case?

52 responses

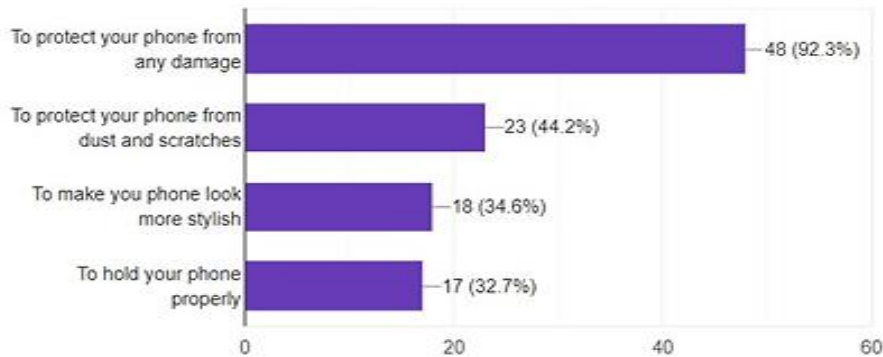


Figure 2. Database of mobile cover.

There are two types of product architecture:

1. Integral
2. Modular

Modular type of Product architecture: - In this type each implements one or few functional elements in their entirety. This is less expensive than the other as it uses standard components Here if one element fails it can be easily replaced.

In The Integral Type, When We Need to Make A System – Or A Frequently Used Function In A System

very fast, we write it from scratch. We also structure the data used by the system in such a way that it can be processed very rapidly. This goes for both bulk performance of things like database lookups as well as quick response for simple things like mouse movements. Integration can also be used to enhance reliability and resilience. Instead of using a common error-handling routine, core functions will include their own error handling to achieve the most rational form of retrying and rebuilding data structures before giving up and failing.

Product Architecture in Case of Mobile Back Cover

Modular product architecture concept suits best for mobile back cover case. In the mobile back cover design two chunks such as physical and functional has been identified and presented as follows and which interact with each other in possible ways (Table 1).

Physical chunks

1. Frame of the mobile cove (silicon)
2. Solid color
3. Lightweight
4. Suitable material

Functional chunks

1. Dust and scratch proof layer at the back
2. Edges to protect camera
3. Grips at the edges
4. Better button reach

CALCULATIONS

$$Weight = (9 \times 1) + (8 \times 1) + (7 \times 1) + (6 \times 3) + (4 \times 3) = 54$$

$$\begin{aligned}
 \text{Cost} &= (9 \times 3) + (6 \times 3) + (5 \times 3) + (4 \times 3) + (3 \times 3) + (2 \times 1) + (1 \times 3) = 86 \\
 \text{Material} &= (9 \times 3) + (8 \times 3) + (7 \times 3) + (6 \times 3) + (5 \times 3) + (4 \times 3) + (2 \times 2) = 121 \\
 \text{Shape} &= (8 \times 3) + (7 \times 3) + (6 \times 2) + (5 \times 2) + (4 \times 2) = 75 \\
 \text{Thickness} &= (9 \times 2) + (8 \times 1) + (7 \times 1) + (6 \times 3) + (4 \times 3) = 63 \\
 \text{Reach of Buttons} &= (8 \times 2) + (7 \times 3) = 37 \\
 \text{Customization} &= (8 \times 2) + (7 \times 2) + (3 \times 1) + (2 \times 3) + (1 \times 2) = 41 \\
 \text{Design} &= (8 \times 3) + (7 \times 2) + (6 \times 1) + (4 \times 2) = 52 \\
 \text{Ergonomics} &= (9 \times 2) + (8 \times 3) + (7 \times 2) + (6 \times 3) + (5 \times 2) + (4 \times 3) + (3 \times 3) + (1 \times 2) = 107 \\
 \text{Aesthetics} &= (8 \times 2) + (7 \times 2) + (4 \times 2) + (2 \times 3) + (5 \times 2) = 61
 \end{aligned}$$

Quality functional deployment or QFD is done so that a manufacturer can be more customer driven, it reduces implementation time it promotes team work and also it provides documentation. Because of QFD we can use competitive information effectively, we can prioritize resources and also are able to identify items that can be acted on. It limits post-introduction problems and avoids future development redundancies and thus is very suitable for any startup. It also creates global view out of details.

The reason to take a lot of customer requirements is to understand customer better. By doing this we get to know about what does customer really want? what are customer expectations? what can design team do to achieve customer satisfaction?

QFD adds structure to the information. It also provides framework for sensitivity analysis. Doing such a detailed calculation will help us a lot in the future to make our product competitive and unique in market. By doing QFD we could generate a lot of concepts and use them accordingly for respective purpose.

By doing QFD we get a detailed structure format of concepts and relation between customer requirement and technical parameters It can be easily observed from the QFD that design for assembly is the most important parameter and then design for manufacturing.

Table 1. Market Parametrs.

Technic description	al Points	Weight	Cost	Material	Shape	Thickness	But to n reach	Custom i.	Design	Erg on.	Aesth	A	B
Custom Requirement	R												
Durabilit Y	9	O	⊙	⊙		●				●		G	F
Grip	8	O		⊙	⊙	O	●	●	⊙	⊙	●	F	P
Fitting	7	O		⊙	⊙	O	⊙	●	●	●	⊙	F	G
Light Weight	6	⊙	⊙	⊙	●	⊙			O	⊙		G	F
Dustproof	5		⊙	⊙	●					●	●	F	P
Shock Resistanc E	4	⊙	⊙	⊙	●	⊙			●	⊙	●	F	F
Warranty	3		⊙					O		⊙		G	F
Colour	2		O	●				⊙			⊙	F	[
Affordabl E	1		⊙					●		●		F	G
Rating		54	86	121	75	63	37	41	52	107	61		

- Weak relation
- ⊙ Medium relation
- High relation
- G Good
- F Fair
- P Poor

CONCEPT GENERATION, SELECTION, AND TESTING

Concept Generation of Mobile Cover

Many concepts were generated by market survey as well as by brainstorming. But since almost each one of use a smart phone these days it was a bit easy to know what people want from a mobile back cover.

Some suggestions are listed below:

- Material must be light weight
- Aesthetic must be unique
- Proper grips must be provided
- Edges to protect camera
- Cost must be minimal
- Dust and scratch proof layer

Concept Screening of Mobile Cover:

This was done via QFD (Quality function Deployment) technique. Thus, techniques help in finding the high demand requirement and the low demand requirement for people by giving points and analyzing the product features and what a customer wants. House of quality chart is prepared and points are given also 2 ore more products which are already present in market are compared for better understanding of the features and we are able to screen them. Here in mobile back case, we found that material and cost were the highest demanded requirement along with the grips.

Concept Testing of Mobile Cover

By making the design on CAD we can test our product and further research could also be done. These features are important we can find be aesthetic and ergonomics consideration testing also.

Aesthetics and ergonomic considerations of a mobile back cover:

Aesthetic Considerations for Mobile Back Cover

Appearance/color: Solid Color (Ex: Black)

Size: 15-16 cm

Shape: Standard rectangular shape (According to the mobile's model)

Material: Silicon

Ergonomic considerations for mobile back cover

Grip: Proper grip on the edges of the cover from where we hold it

Manufacturing: Molding of the base material

Weight: Light in weight around 20-30gm

Thin layer at the back: To protect the cover from dust and scratches

DESIGN OF MANUFACTURING

Design Specifications

Length: 16 cm Width: 7.5 cm Height: 1cm

Material: Silicon (Silicone is such a flexible material that it can absorb shock unlike any other phone case material like plastic or leather. Unlike other rubbers, too, silicone holds up exceptionally well in cold environments, sometimes as low as -60°C).

Manufacturing process: Selecting material and then heating the plastic material at high temperature so that the plastic is melt, putting a solution into a mold and closing the mold; cooling the mold and taking out a mobile phone mold. The mobile phone cover manufacturing process disclosed by the invention is simple and easy to operate.

Costing: Silicon is readily available at a rate of approximately Rs. 200- Rs.300.

DESIGN OF ASSEMBLY

Molding machine is used for making mobile back cover. Its cost ranges in between 7-10 Lakhs. Labor used to operate the machine is semi-skilled while labor used to test, supervise, maintain the machine, etc. is skilled. Also, unskilled labor is used to supply the raw material, workspace cleaning etc.

CAD Model

In Figure 3-5 show the CAD Model of Mobile covers

Design for Environment for Mobile Back Cover

Firstly, for making covers we mainly use silicon, leather, plastic or fibers. Silicone isn't the most environmentally friendly material on the market. Producing silicone uses hydrocarbons derived from petroleum, which isn't sustainable. It's difficult to recycle, and most facilities won't accept it. Unlike other materials such as plastic, it takes quite a long period for silicone to decompose. Silicone is known to be one of the strongest material components found around the globe and hence it is used to make covers to protect our device from any damage. For leathers it can be replaced by human made leather which will indirectly help in not harming the animal and protecting the wildlife and environment. Also, fibers are biodegradable and mixing them with other material can increase it strength and can be used as a mobile back cover material. Further it can be noted that use of plastic covers is also bad for environment and other sustainable materials can be definitely used. Further the packaging of mobile covers can be done in either paper bags or fiber bags to reduce the use of harmful plastic also we can reduce the carbon footprint.



Figure 3. Mobile back cover (back view).

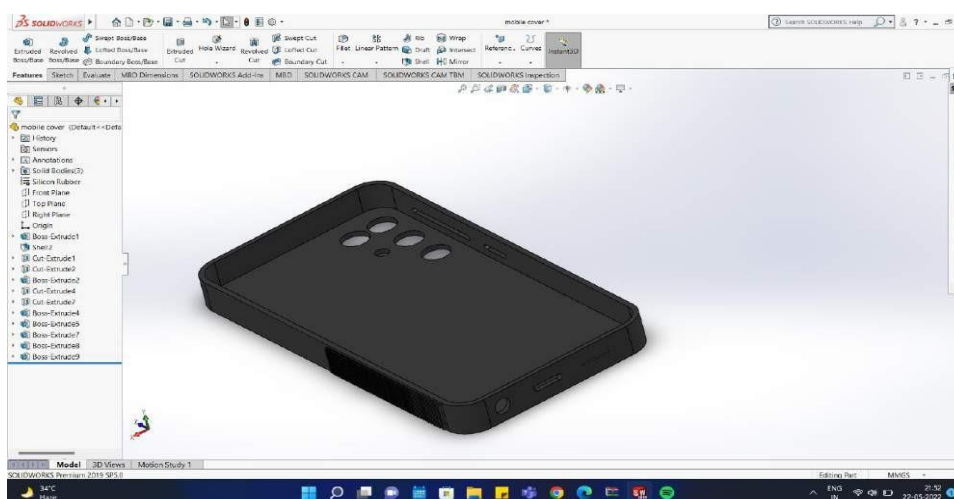


Figure 4. Mobile back cover (isometrical view).

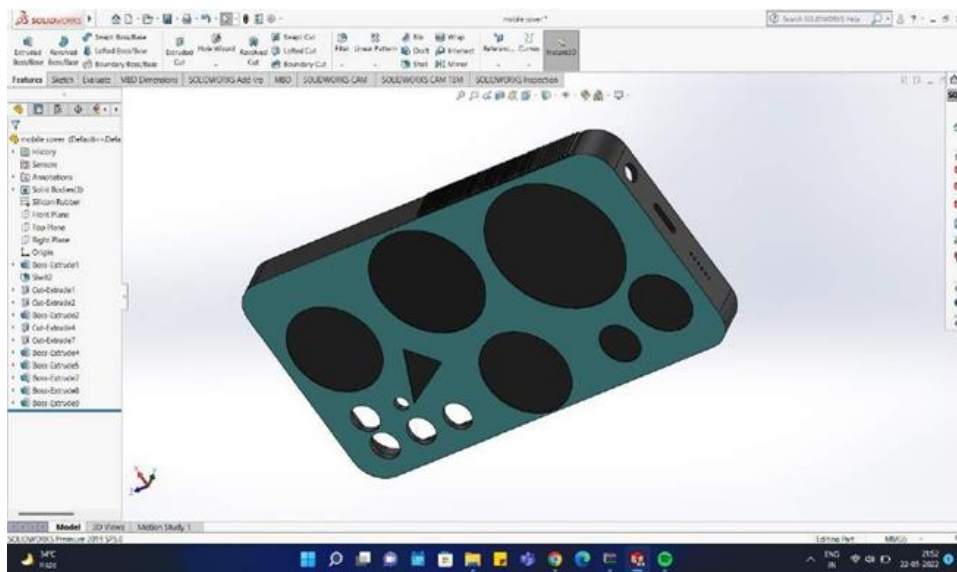


Figure 5. Mobile back cover (side view).

PRODUCT LIFE CYCLE OF MOBILE BACK COVER

Introduction

First of all research is done on our product mobile back cover which can be done by use of internet, research articles or by customer survey. Also, house of quality chat is made to understand the required features in a better way. Marketing survey in order to: 1. Make better marketing decisions, 2. Understand consumers and the marketplace, 3. Find out what went wrong. It was found that most of the pupils are from the age group 18-25 years of age. 98% of them use a mobile back cover and have faced issue during its use. Over 50% of the pupil use a silicon-based cover and about 84% of them don't want a flip in their cover. In addition to this, they also need raised edges for camera protection and want it to be light in weight. Proper grip is also a requirement for 96%. They also need a scratch and dust proof layer and extra protection on the corners of the cover. A huge response has been received considering aesthetic look where 70% of them want it to be of solid colors and 17% of them want it to be printed.

Growth: Once the product is surveyed and the design is ready to manufacture then the growth phase of the mobile back cover starts. People start liking the product and are ready to buy it. Popularity increases as the quality and required features are present in the product. In addition to it marketing is done so that people get to know about the cover and buy it.

Maturity: Now as the features and add on cost and material is liked by the customers the product gets stable in the sales market. This is the stage where the team have to introduce some new features to the product or launch some more similar upgrade products so that it can walk with the market and grow. New features in my product could be stand or color changing covers etc.

Decline: A product declines when no new features are added to it and other brands introduces new and upgraded products in the market this leads to the customers attraction towards the new market launched products and people stop buying it.

CONCLUSION

Mobile back covers are extensively used by almost all age group people and is in high demand nowadays. Any product if wanted to be established in the market then going through the above procedure will not only help in doing it but also solves a lot of problems and makes our product unique. It is understood from above study that proper grip and aesthetics along with dust and scratch proof layers is very important and feasible. For manufacturability we can use molding techniques and instead

of silicon we may use fibers mixed with other material to give it strength this will result in saving environment from harsh plastics. Using paper based packaging is also an alternative. So, a great design with the high demand features and requirement and along with environment friendly design is what comes out of the above study.

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