RE-DESIGN OF MOTORCYCLE HELMET

PRODUCT DESIGN PROJECT III

BY

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GUIDED BY

PROF. B K CHAKRAVARTHY

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Approval Sheet

The project titled as " Redesign of Motorcycle Helmet" by Isaac Junior is approved in partial fulfilment of the requirement for the degree of ' Master of Design' in Industrial Design.

Guide :

Chairman:

Internal Examiner:

External Examiner:

Declaration

I, hereby, declare that this written submission represents my idea in my own words and where others' ideas have been included; it has been adequately cited and referenced the original source. I also declare that we have adhered to all principles of academic honesty and integrity and have not misinterpreted or fabricated or falsified any data/idea/facts/sources in our submission. I understand that any violation of the above entitles the institute to take disciplinary action against me to which I shall be answerable to.

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Abstract

Riding has been by far given the most relaxing and exhilarating experiences I've ever had. The sense of freedom it bestows the rider with is beyond measure. Being exposed to the environment and living in the moment could not be better way to exist, but it poses a sizable amount of risk for the rider and pillion, considering that it's a mode of transport prominent for commute. Even after being made mandatory, a large population of riders still refrain from wearing a helmet while on road.

This project explored the user perspectives and his deep rooted conventions about the practice of wearing helmet. The psychological and physical notions associated with were studied. The structural composition of motorcycle helmet has remained constant since inception – hence an attempt was made to bring in novelty in this aspect as well as methods to facilitate regular use by improving aspects of comfort and accessibility. Eventually style matters for a product that the user considers an extension of his personality and could not be disregarded. Hence the functional advancements were given life through prominent styling that imparted a character to the helmet.

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INTRODUCTION

Motorcycle Helmets

It's a very well-known fact that for two wheeler motorists, helmet is an essential piece of life saving equipment, rather than an accessory. Making its use mandatory may leave arguments among the motorists, but there is no question regarding the capacity of helmet to prevent head injuries during an accident.

Motorcycle helmet industry has been growing from its inception over the past 50+ decades. Various advancements in science and technology are getting integrated to the framework of ' safety requirements' to produce efficient, comfortable and sleek motorcycle helmet designs [Fig 1] . The fact that rider is actively engaged with his senses while using helmet also adds a dimension to helmet, making it primarily an ' in the moment' product. But explorations in styling, functionality, and acceptance have led helmets to be seen and treated as an extension to self and the machine one rides. Motorcycles are famous for the innate experience it gives to the riders and also the number of road accidents they're involved in. Helmets are therefore a must-have while riding, as they reduce the risk of head injury considerably [by 69%] and accidental death [by 42%] .

Fig.1: *SHOEI Quest passage helmet*

Fig.2: *Spartan war helmet*

Fig.3: *Bell helmets from early 1960's*

A Brief History

The history of head protection dates back centuries to the time when it was used mainly during wars to save one's life [Fig 2] . It's worthy to note that the purpose essentially remained same even back then. Pith, leather, beaten metal were few of the materials that were used to manufacture helmets back then.

To delve into the recent history of motorcycle helmets, one has to start from early 1914. Brooklands race track was the first purpose-built racetrack in the world, situated in Surrey, UK. A medical officer Dr Eric Gardner noticed riders suffering from head injuries at a frequent rate. His ideas regarding a protective head gear resulted in canvas and shellac helmets.

When these were presented to the Auto-cycle union, they initially condemned the creation, but later accepted it and made it mandatory in the greatest & deadliest race of all times – Isle of man TT. The notable difference was that none of the riders suffered from concussion during the race in 1914 – a first ever feat.

In 1935, T.E Lawrence – a very famous and highly decorated WWI British soldier lost his life 6 days after a motorcycle accident. Hugh Cairns, a neurosurgeon who attended Lawrence, began researching upon loss of life in motorcycle accidents. Cairns successfully persuaded the British government to make helmets mandatory and it became a civil law from then on.

During 1960s the usage of fibreglass shells and cork lining improved the quality of helmets than its predecessors but face protection was not given due consideration [Fig 3] . Mid 1970s saw the advent and popularity of helmets with face protection. The basic types of motorcycle helmets present today include the

Full face [Fig 1]

Off-road / Motocross [Fig 4]

Modular / Flip-up [Fig 5]

Open face / Three-fourth [Fig 6]

Half helmet [Fig 7]

Fig.4: *Motocross helmet*

Fig.5: *Modular helmet*

Fig.6: *Open face helmet*

Fig.7: *Half helmet*

PRIMARY RESEARCH

Survey Groundwork

To approach the process of survey and to draw meaningful conclusions, a brief study into human psychology, choice architecture and cognitive biasing was required. This was required to better understand the thought process and behaviour of two wheeler motorists. Daniel Kahneman's (Fig 8) book Thinking Fast and Slow (fig 9) was real help in this regard. He was an Israeli-American psychologist who worked in the area of behavioural economics, for which he was awarded the Nobel Prize in 2002.

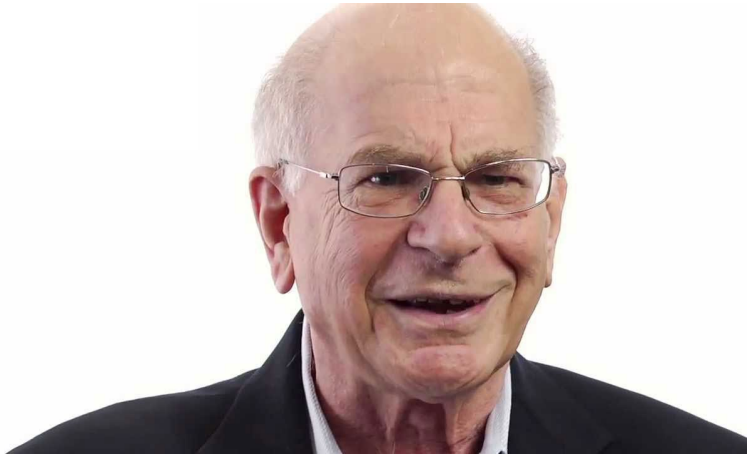


Fig.8: *Daniel Kahneman*

Thinking Fast & Slow

The book focuses on two modes of thinking - Fast and Slow (System one thinking & System two thinking) . To get familiarised, the moment we are given a question / a set of words (e.g. Mother) / a particular problem such as 2+2 =? , certain reactions happen within us. These reactions are spontaneous and sometimes trigger emotions while being in the passive mode. Passive mode

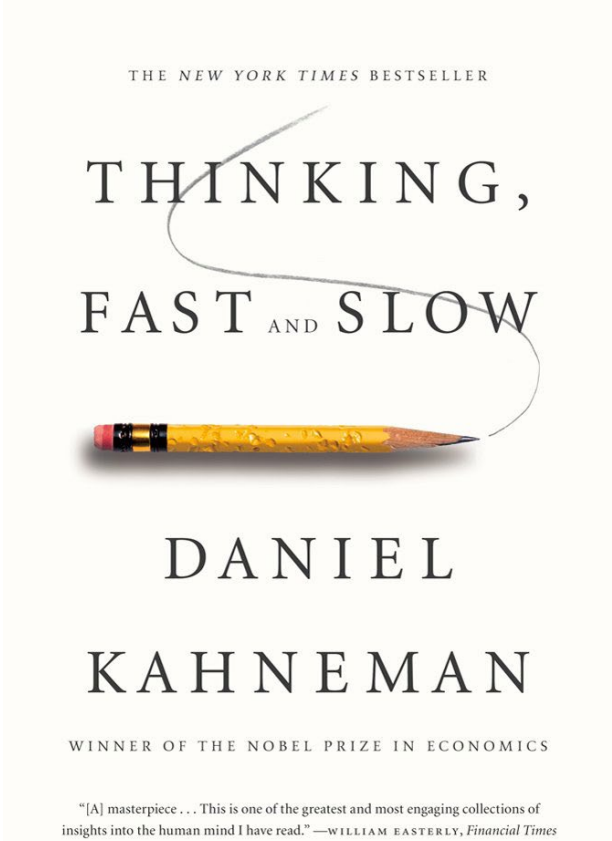


Fig.9: *Book Cover*

as in - we didn't have to consciously decide to compute 2+2 nor evoke the emotion we associated with ' Mother'. This is an example for Fast thinking.

But when a particular arithmetic problem such as 34 x 23 is given, there occur a set of chain reactions within our mind which enables us not to find the correct answer instantaneously, but to draw the environment / probabilities associated with it. We may decide whether this could be calculated mentally or not, whether the answer lies between 100 or 10000 and so on. There are a set of such information which gets generated as part of Fast thinking, but in order to find the correct answer for the problem one must do mental work. Mental work is associated with effort which can be observed in terms of dilated pupils, increased heart rate etc. Another easier example would be when you restrain yourself from getting angry at someone, which is a product of slow thinking. These are examples of slow thinking.

The slow thinking involves the control of attention. Attention and effort is considerably employed in the above cases. System one is closely associated with skill behaviour. For example the activity of driving a motorcycle which was initially a system two operation becomes system one operation over a period of time. There are things you learn which over a course of time becomes automatic. Humans do approach activities generally by the principle of least effort. To attain a goal, we calculate the amount of physical as well as mental effort that's required in achieving it which in turn translates as a ' cost'.

While these two systems seem to equip one to perfectly deal with the world, they in turn create some problems. The reason being that in circumstances when slow thinking is appropriate, fast thinking kicks in, which manifests as our trusted intuition that leads us to the wrong answers and the wrong conclusions. Our drive us into conclusions, right or wrong and rarely do we take the time to second-guess our intuition. Thus, we make erroneous decisions and conclusions based on short cuts we didn't even realize existed.

Fast thinking is not always wrong – and in many cases it's necessary. Kahneman is not arguing that we are making wrong decisions consistently, only that we are far less rational than we believe ourselves to be.

Cognitive Bias

Cognitive bias is the characteristic of humans to think in particular ways. This behaviour causes deviations from the logical/rational standards – where the standards describe the commonly accepted notions. Whenever humans are required to make a decision [cognitive bias does kick in] , it puts cognitive load on them. Heuristics is one way to quickly go about it. It's a speedy process based on previous experiences. The solution or decision that comes out of employing this method might not be the optimal one, but would guarantee to solve the problem at hand. Heuristics is a bunch of simple efficient rules laid out by evolutionary process within humans. Motivation or wishful thinking is another cognitive bias that comes up during decision making. When a precise catalyst [motive] prompts specific behaviour, it can be called as Motivation / wishful thinking.

Several commonly debated biases occur during the process of decision making of which few are –

PRIMING – It can be defined as the increased sensitivity to a particular schema due to a recent experience. A schema can be defined as the mental framework or concepts that we use to organize and understand the world. An example for this would be the case wherein an expectant parent associates most of the events around him/her to babies.

AVAILABILITY HEURISTIC – It's a mental short cut that helps us make decisions on how easy it is to bring something to mind. It manifests when we think of examples while making a decision or judgement. If several examples are readily available in our mind, the event we are about to address gets biased by them.

AMBIGUITY EFFECT – We end up selecting/choosing options of which the probable outcomes are known to us.

ATTENTIONAL BIAS – Our repetitive thinking process creates this bias in which we tend to focus on things we pay more attention to, while neglecting or ignoring other possibilities.

User Interaction & Analysis

The primary research was conducted to understand the user perspectives regarding the use of helmet. A lot of 22 people were interviewed in detail. The sample included different segments of motorcycle users, mainly –

Street racers

Enduro racers#

City commuters

Office commuters

Long distance tourers

The important question - Why motorcyclists refrain from using helmet, even though it's mandatory by law – was the focal point of survey. The reasons that they put forward for not using one, the positive factors that persuaded people to wear / like a helmet, their behaviour while on Indian roads and their usage patterns were few of the aspects familiarised as part of it. The sample was

#Off road riders over long stretches

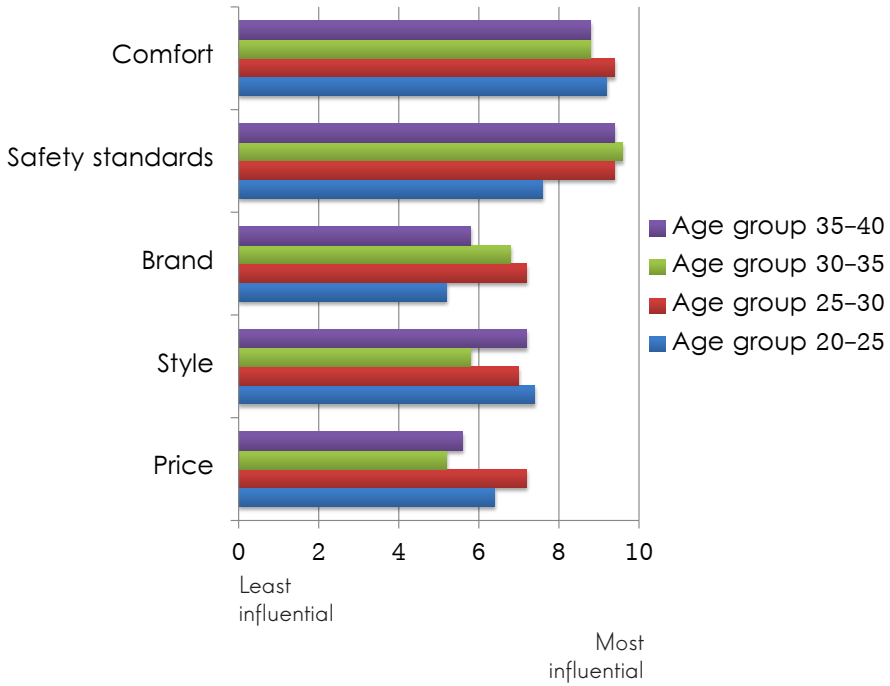


Fig.10: *Different purchasing factors*

divided into four age groups of five members each, amongst which two wheeler usages were found to be considerably high. These were 20-25yrs, 25-30yrs, 30-35yrs and 35-40yrs. The survey included users who did and did not own a two wheeler.

Different purchasing factors

Different factors that help user make a decision while intending to purchase a helmet was listed out after the sample survey. The factors were – Comfort, Safety standards, Brand, Style factor and Price. Users were then asked to rate the same according to the importance it holds in the decision that they would make. The scale provided was from zero to ten, with zero being least important and ten the most.

The graph [Fig 10] indicates the choice that Comfort and Safety standards rate as the important factors while buying a helmet across all age groups. The choices users made here can be related proportionally to their income and riding tenure. Age group 20-25yrs rated Style / Styling factors important after the above two,

highlighting the desire to choose a trendy product. Amongst all the groups they rated Safety standards & Brand the least which seemed worrying as it gives the picture that they do are not concerned much about the quality of helmet.

As people mature the choices they take seem more composed, as the results of age group 25-30yrs say. They have an almost equal preference/rating about Brand, Style and Price. The group rated them as important, but not as much as Safety & Comfort.

Age group 30-40yrs have the higher rating for Safety than for Comfort which was funnily put by one of the interviewee as – " It's like aged whiskey. As the number of years increase, the better the bottle becomes". Age group 35-40yrs do have a heightened liking for Styling too.

Behaviour on Roads

Indian roads and traffic are such that it demands the rider to adapt to the surroundings – surroundings that tend to shift quickly and frequently. The adherence to traffic laws [Fig 11] is moderate in the

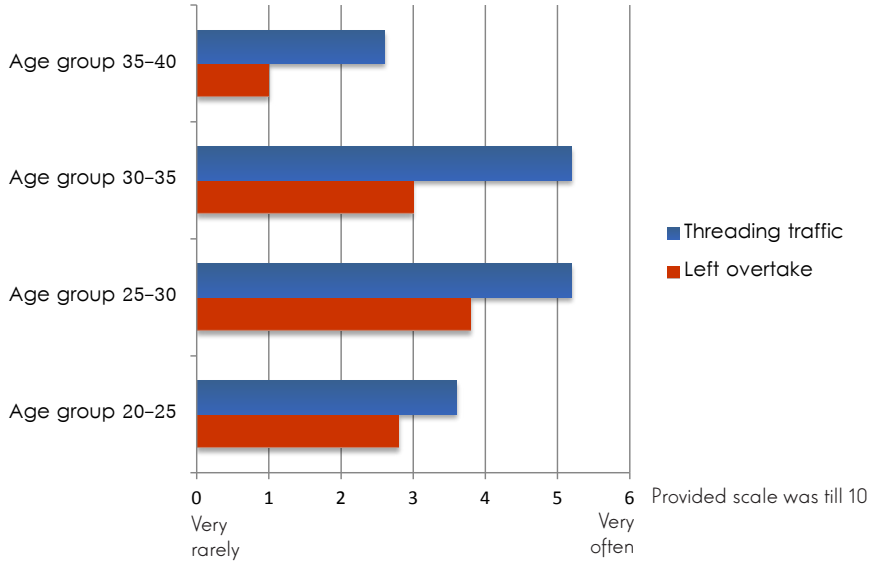


Fig.11: *Behaviour on roads*

country with increasing number of adherents every year. Whether it is to reach the destination quick, to avoid pollution on roads or to get the adrenaline rush, riders tend to break traffic law. This behaviour gives an idea regarding the amount of risk a rider is ready to take on road and the kind of protection he must have.

Even though overtaking another vehicle through the left side is not permitted by law, it's hard to find someone who has not broken the rule even once. Such is the condition when it comes to threading through traffic too [zigzag riding pattern between other vehicles/ lanes] . Traffic in our tier one and tier two cities would easily force a rider to thread through traffic.

Threading through traffic was found be mostly done by the age group 25-35yrs with most of them citing the reason as office commute. Risk averse nature explains the drop in both violations for the age group 35-40yrs.

Perceived adherence to law

It is mandatory by law to wear helmet for all two wheeler

riders. The user's perceived adherence to law is one of the factors that trigger the usage of helmet, apart from self-awareness of safety. Hence the same was subject to study. ISI / BIS standards ensure the safety and quality of the helmet that's purchased, but it was found that a minor percentage of riders (9%) did not find this as an evaluating criterion when they bought helmets. The tendency to take quality for granted when you purchase a helmet was widely observed.

The scenario when you are caught for not wearing helmet was associated with minor fines / pleading with the officer by the users. These instances were of petty importance as far as the majority of the users were considered. But due importance and compliance was given to the traffic lights by majority of the users.

Purchasing power

Even though the current helmet market has internationally acclaimed helmets [AGV, SOL, Arai, SHOEI, FOX etc.] ranging from INR 5000 to 20000 the general trend amongst motorcyclists is to go for helmets less than 6000INR [Fig 12] . While users from

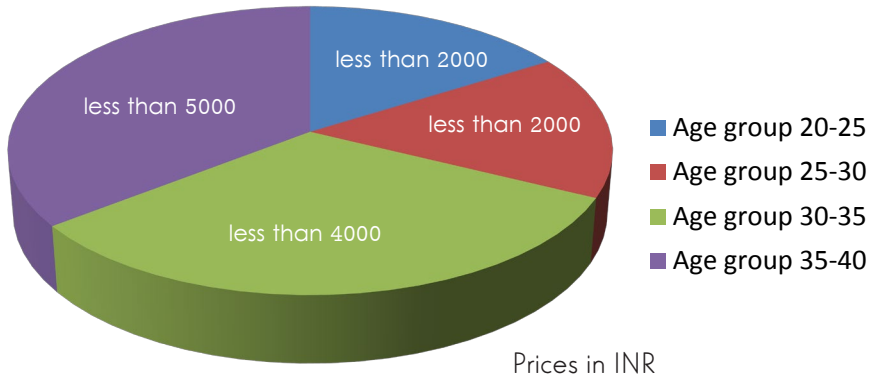


Fig.12: *Purchasing power*

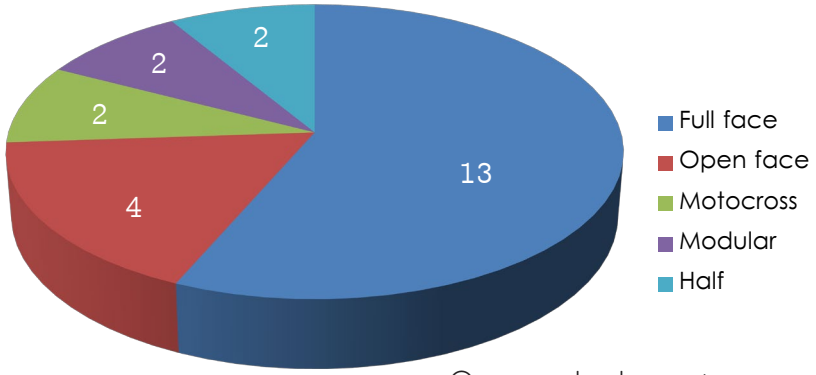


Fig.13: *Choice of helmet*

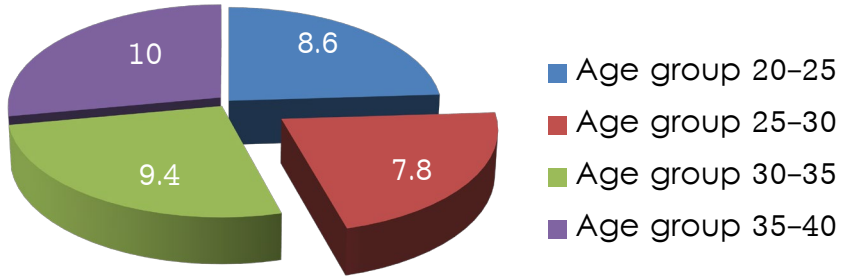


Fig.14: *Helmet usage*

20-30yrs preferred one below 2000INR, the other age groups were comfortable till 5000INR.

Choice of helmet

Users were presented the basic options that come in motorcycle helmets to understand which one they opted for. Most of them chose the full face helmet [Fig 13] for reasons of safety, comfort and sense of security. Users who opted for others had specific reasons to do so including hindrance to face, claustrophobia, visibility, styling etc.

Helmet Usage

The helmet usage was comparatively low for 20-30yrs [Fig 14] . The helmet usage depended on many factors. For few riders helmet was a must every time they step out with a motorcycle, whereas for others it depended on traffic, police in the vicinity, grocery shopping nearby etc. The latter lot opted

helmets only for long commutes as they believed short runs nearby posed least or little danger.

User caution / Risk level

The use of helmet is primarily for one's own safety and should not be associated to an enforced action as per the law. People who realize that helmet is for their own safety form the majority, but there exist a considerable segment of users (22%. Fig 15) who wear helmet out of compulsion or fear of authority.

Wearing protective gear (Fig 16) while riding is also another scale with which we can analyse the amount of risk a rider takes on road. Sensible riders generally wear shoes while riding, and it was found that within the age group of 20 to 30 only 55% wore shoes regularly which increased to 70% for age group of 30 – 35. It declined for the age group 35 – 40 furthermore as people upgrade to four wheelers by that period.

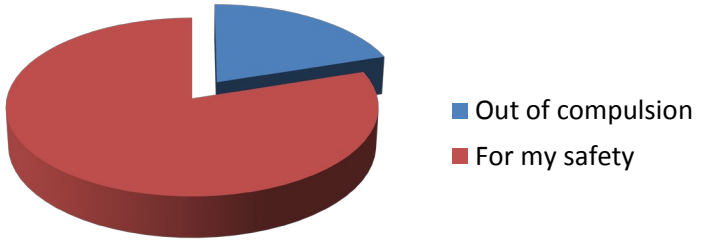


Fig.15: *Why wear a helmet?*

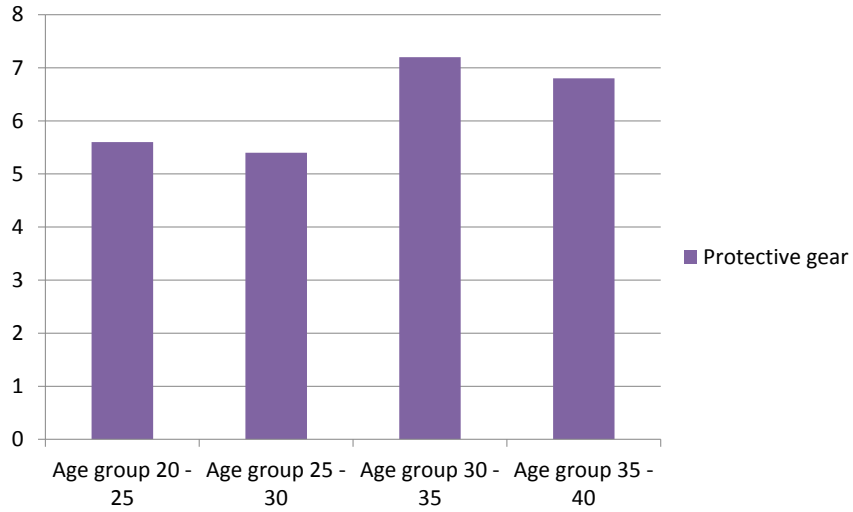


Fig.16: *Protective gear usage (on a scale till 10)*

Value for life / pillion

Even though majority of the riders have a pillion, they seem to never ask the pillion to wear a helmet. Few of the users perceived it as a responsibility of the pillion rather than of themselves. The main idea of wearing helmet so as to avoid police checking seemed to take prominent place rather than the protection of life. Difficulty in carrying extra helmet was cited as another cause for not persuading the pillion to wear one. Few of the users were unaware of the fact that in case of an accident the pillion is at greater risk, and hence were blatant in suggesting that the pillion doesn't require a helmet.

Factors affecting Regular use

Most of the users interviewed did use two wheelers for their office commute and road trips. They were subjected to different types of traffic and road conditions. Few of the users had a passion for street racing, enduro and off road riding.

The major problem affecting the regular use of helmet was its safe storage. They found it difficult to carry with and the existing helmet locking facility requires an additional attachment that gets mounted on to the tail grab or crash guard in two wheelers. The fear of getting looted if you own an expensive helmet was also a deterring factor.

There were many feedbacks related to the comfort level within a helmet. Sweating, weight, claustrophobia in a full face helmet, damaging hairdo, visibility issues, audible noise levels were few of the problems mentioned. Age group of 20 – 25 had least comfort in a helmet, but as soon as they upgraded to a new helmet as seen with the age group 25 - 30, their comfort levels soared up.

Insights

Closed-ended and open ended survey methods were understood and employed as part of user study after the survey groundwork. Daniel Kahneman's Thinking fast and slow provided a glimpse into how the system 1 and system 2 approaches are taken by a user, regarding his behaviour on road and choices he makes.

Closed-ended survey provide quantifiable data that provides statistical significance to survey results. Questions like purchasing factors & power, choice of helmet, behaviour on roads helped classify users into groups. This knowledge helped to move forward with an action plan on how to cater to this niche better or break into other target demographics.

Open-ended questions are exploratory in nature. It allows users to provide any answer they choose without forcing them to select from concrete options. It helped in collecting rich qualitative data regarding perceived adherence to law, value of life, factors affecting regular use and user caution/risk level. However, being qualitative in nature makes this method lacked the statistical significance needed for conclusive research. This method required far more effort in analysing and deducting data.

The survey undertaken had limitations as the sample set was less than 33, which is the minimum number of interviewees required to substantiate the drawn conclusions. But nevertheless the insights drawn from the survey did throw light upon the hassles faced by the riders with a helmet, riding patterns, safety considerations and accepted risk levels.

Considering the climatic conditions of our sub-tropical nation, the main reason why motorists tend not to wear the helmet would be the comfort issues posed by it. Comfort factor took the forefront while considering purchasing a helmet. Safety, even though was rated second highest, was taken for granted. Styling was the next leading factor in choice of a helmet. The different problems outlined by users were –

Sweating Storage Visibility Claustrophobia

Hair loss / Hairstyle Noise level Riding in rain

Communication troubles with pillion & phone calls

SECONDARY RESEARCH

Manufacturing

The secondary research looked into helmet manufacturing technologies, medical factors related to motorcycle accidents, types of brain injuries sustained, what happens with and without helmet in case of an accident, innovations in helmet design - both conceptual & in market and previous projects done in IDC.

Process

The basic components of a helmet include a Shell and a liner. [Fig 17] The lack of data from leading manufacturers owing to confidentiality of their processes/technology posed limitations in understanding the minute details of design/manufacturing.

The common process followed across different helmet manufacturers include creating a composite shell, laser cutting the visor opening and vent holes, undercoating and sanding the shell (twice) for even surface, drilling holes on it for ventilation duct attachments / visor / chinstraps, inserting the inner lining and attaching visor / ventilation duct controllers [Fig 18 - 25] .

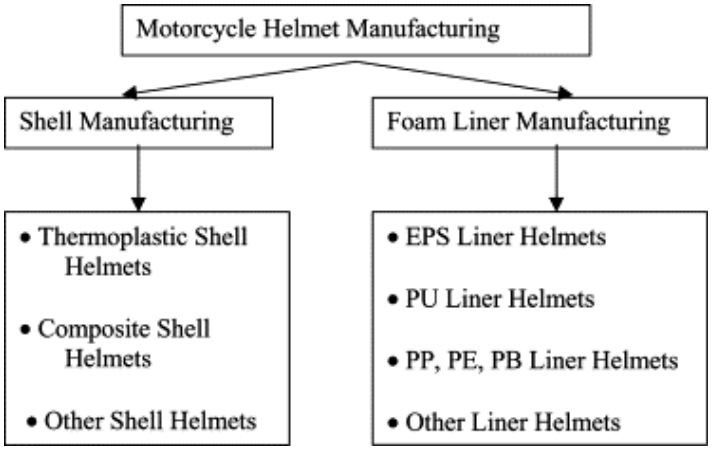


Fig.17: *Manufacturing methods*

Fig.18: *Material fibre*

Fig.19: *Moulding fibre layers*

Fig.20: *Moulded shell*

Fig.21: *Vents are cut*

Fig.22: *Undercoat & sanding*

Fig.23: *Visor & chinstrap holes*

Fig.24: *Fitting inner liner*

Fig.25: *Fitting visor & ducts*

1. Shell manufacturing

The shell is the first element to have contact in case of an accident. Hence the structure has to be sturdy enough to receive the impact energy and divert it across the surface and into the liner. Shell should be such that upon critical force, it should not be pierced.

1. Thermoplastic shells – ABS and polycarbonate are used. ABS is preferred for its better crash test performance. These materials upon exposure to weather over long courses tend to become brittle. Process employed mainly is Injection moulding.

2. Composite shells [Fig 18 - 20] – Reinforced glass fibres / Kevlar / carbon fibre are applied in layers using adhesive and moulded to create the shell structure for the helmet.

3. Reinforced shells – Utilizing advantages of both processes above. Injection moulding process in employed in which the raw material is embedded with glass fibre inserts. The inserts require pre-manufacturing increasing the cost.

2. Liner manufacturing

The function of the liner from the safety perspective is to absorb the energy and prevent injury to the skull. Different materials are used in liner [foam liner] . They include –

- EPS liner helmets [Expanded polystyrene]
- PU liner helmets [Polyurethane]
- PP, PE, Pb liner helmets [Polypropylene, polyethylene, polybutylene]

EPS & fabric liner [Fig 26] is widely used for its light weight and better performance. The type of liner used depends upon the comfort level, atmospheric conditions and conditions of use.

Fig.26: *Fabric liner [SHOEI GT-Air]*

Human Head & Impact

The leading cause of motorcycle accident fatality is injury sustained to the head & brain. Hence Traumatic Brain Injury [TBI] - the injuries affecting brain / head is of utmost importance. The common symptom seen in motorcycle accidents is concussion. The person may be confused / unable to concentrate / become unconscious. But the brain has the capacity to recover from this state back to normal.

Direct trauma (cases in which head collides with force, leaving brain injured) , Indirect trauma (cases in which head does not collide, but motion of head relative to neck leaves brain injured. E.g.- Whiplash injury [Fig 28]) , Post traumatic injuries (A traumatic event causing hormonal/chemical changes in brain that have prolonged effect) , Injury by lack of Oxygen – Anoxia(The case when breathing does not happen normally resulting in permanent brain damage within 8 minutes) , Edema(Swelling of the brain, reducing the amount of blood / oxygen to the brain) are the injuries most listed in case of motorcycle accident deaths.

1. Coup - Contrecoup Injury [Fig 27]

One of the two major brain injuries in which the brain is left bruised at both ends. The skull bends in at the end, towards which the head was moving before impact, causing injury to the brain as well as setting the brain into motion. The brain moves backwards and hits the skull to cause the second injury.

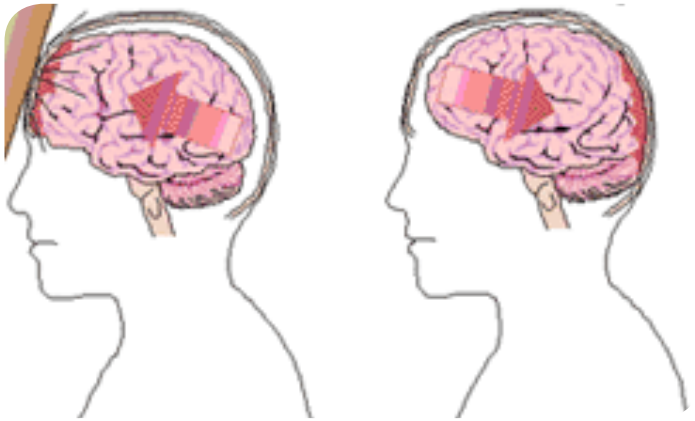


Fig.27: *Coup - Contrecoup injury*

2. Diffuse axonal injury

When head / neck is subjected to rotational forces, brain tissue gets injured. This injury causes widespread damage to the brain rather than a focal one [similar as in Fig 28] .

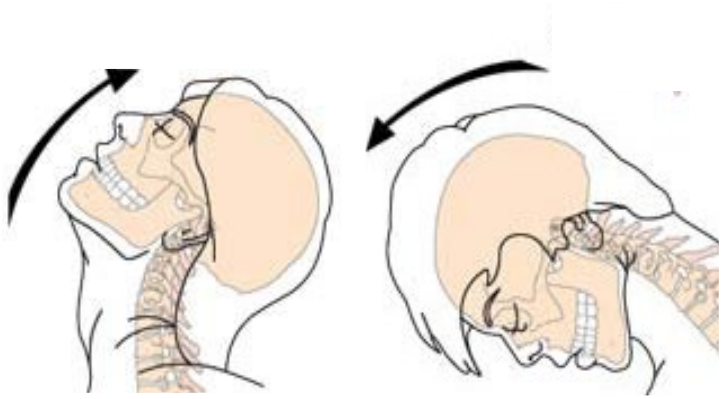


Fig.28: *Whiplash injury*

Intracerebral haemorrhage (bleeding in the brain) , Epidural hematoma(blood clots that appear between skull and dura) , Subdural hematoma (blood clots that appear between brain and dura) are some of the secondary types of brain injuries

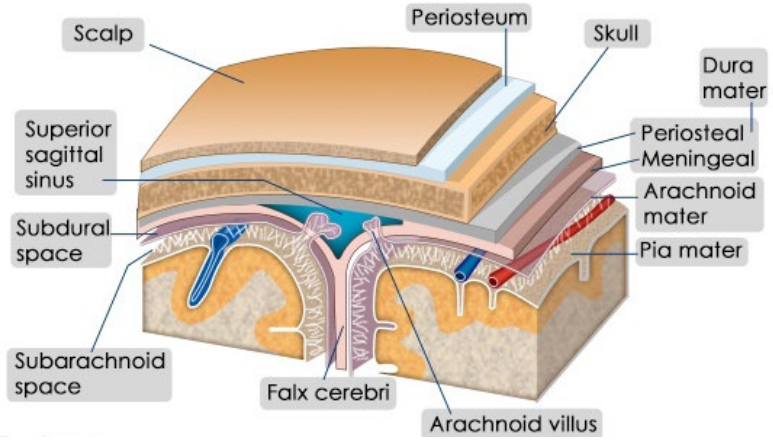


Fig.29: *Dura mater*

that might result out of a motorcycle accident.

Dura [Fig 29] – Brain is protected by meninges. Dura is the 3rd and outermost layer of meninges.

First aid

The first aid response to a motorcycle accident is abbreviated as DRABC [Danger - Response - Airways - Breathing - Circulation] . It provides the order in which a victim should be assessed at the site of accident. Check for Danger and make sure its ok to approach the accident site. Check for response from the victim to make sure whether he is conscious or not. Clear the airways and check for Breathing. Feel the pulse for Circulation / apply direct pressure at points of bleeding.

Previous at IDC

The project by Mandar Kale [2004-2006 PD] on the collapsible helmet design was referred. Design process followed and conceptual ideas [Fig 30,31] were analysed. The concepts generated tried to address the issues of

- Circulation of air within the helmet
- Ease of storage of helmet
- Ease of use [wearing and removing]

The final prototype of the same was observed [Fig 32] .

Final prototype was based upon the solution for easier storage of the helmet. A half helmet was sub divided into two different portions. The upper part could be pushed inside the lower, so as to create a tapering up cylinder volume, which enables easy storage. The helmet could be then stored in a finite amount of space, and even in a backpack.

Fig.30: *Side view iteration*

Fig.31: *Side view iteration*

Fig.32: *Prototype*

TRENDING INNOVATIONS

Helmet Novelty

The major innovations in the design of motorcycle helmets have a recent history, which brings in added values apart from the protective shell & liner layout. Few of the innovations pass the tests required to guarantee the safety and make it out to the market. Lot more innovations remain at the conceptual level currently.

The innovations discussed here are a mix of what is available in the market today and the conceptual ideas.

1. Skully AR 1

Rated to be the most innovative idea in racing helmets yet, this helmet boasts integration of a Heads Up Display [HUD] , rear view camera and a whole lot of other perks such as GPS, navigation, voice calls, music via Blue-tooth etc. One another captivating feature is the trick visor that tints electronically [Fig 33,34] .

Fig.33: *Skully AR 1*

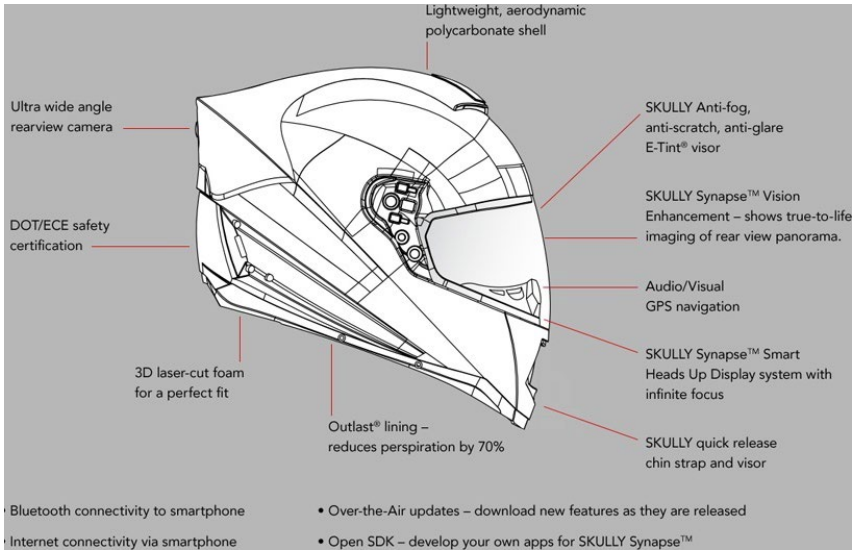


Fig.34: *Skully AR 1*

Fig.35: *MSX1 rear view*

Fig.36: *MSX1 vision system*

Fig.37: *Lightmode power unit*

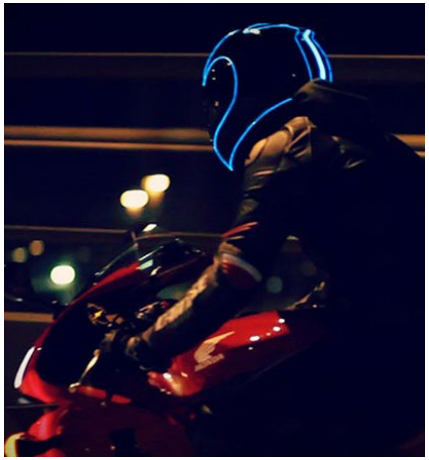


Fig.38: *Lightmode in action*

2. Reevu MSX 1

Created after a research of ten years and 2 million pounds, this helmet was the first to integrate rear view mirror [Fig 35] into a helmet. It's not power assisted, and the mechanism employed utilizes the space in helmet above your head to store a bend mirror [Fig 36] that captures the rear-view and display it on a mirror up front, above the eyebrows.

3. Lightmode

While riding at nights the bothering question was why don't helmets have lights on them for caution / styling The solution came in the form of Lightmode helmets [Fig 38] that use 2 AA batteries [Fig 37] and last up to 13 hours. It has different light modes such as constant glow, slow and fast blink. It uses electroluminescent materials that surround the helmet in 360^0 fashion.

4. APC

These helmets tried to bring in an integrated air-bag into the helmet [Fig 39] . They aimed at keeping the head and neck stable in case of an accident to prevent rotational / whiplash injury. They contain a detection system fitted on the motorcycle to track rapid deceleration and judge accidents. Upon which the charge kept in the light external shell deploys the air-bag [Fig 40] .

5. Superskin Technology

Present in Lazer Helmets, superskin is a technology that mimics the way skin slides on top of skull [Fig 42] . The same principle was adapted for the covering of outer shell of helmet [Fig 41] , thereby reducing chances of rotational impact injury.

Fig.39: *APC helmet*

Fig.40: *APC airbag deployed*

Fig.41: *Superskin technology*

Fig.42: *Skin movement on skull*

Fig.43: *Hovding around neck*

Fig.44: *Deployed airbag*

Fig.45: *BMW Airflow 2*

Fig.46: *NEXX Switx*

Another concept that promised emerging technology was the Hovding (invisible bicycle helmet) . The concept behind the same was why have a solid structure around your head always [Fig 43] Upon occurrence of an event which might cause a head impact, the Hovding deploys itself as an air-bag [Fig 44] and covers most of the head. The concept may seem in the nascent stage, but holds true potential.

Helmets that won prestigious design awards were also looked upon. Few amongst these were the BMW Airflow 2 [Fig 45] helmet and NEXX Switx [Fig 46] helmet. The former was excellent in terms of its aerodynamics, aero acoustics and effective ventilation technology and the latter was notable for its customisable/interchangeable outer covers and a single hand operation enabling 5 air vents across the helmet. The single hand operation slides the customisable outer shell part on the rigid shell structure beneath – thus operating the vents.

DESIGN BRIEF

To design a full face motorcycle helmet

- Prompting regular usage by addressing comfort & accessibility

User Persona

Name - John

Age - 29

Occupation – Bank manager

A long term employee with the bank, John has developed a good reputation with the rest of the employees at the branch. Occasional commuter to work, he currently owns an Enfield desert storm and Ford fiesta sedan. A member of Enfield riders, he goes on tours and social service initiatives of the group. Married, both John and his wife stay in a rented house. Loves classic songs and jazz. Avid footballer and adventurous.

Behaviour on road - Observes traffic rules. Calm and composed. Likes to ride/drive during non peak hours

Frustrations on road – Rash & inconsiderate traffic. Obstacles on road, Going on a wrong route.

Name - Aaron

Age - 23

Occupation – IT Professional

A young employee, Aaron is excited to learn the processes and requirements of his new job. Regular commuter to work and meet ups with friends scattered around the city during weekends. Currently owns a Honda unicorn motorcycle and a Studds helmet. Shares an apartment with colleagues and is unmarried. Technology enthusiastic who keeps himself updated about gadgets.

Behaviour on road - Regular threading. Follows traffic rules in busy locations. Mostly with pillion. Less usage of indicator lights.

Frustrations on road – traffic jams, honking, dust & pollution, getting late to work.

DESIGN EXPLORATIONS

Ideation

The entire ideation process evolved out into two branches. One section dealt with how functional advantages can be integrated into a motorcycle helmet. The second concentrated upon the styling to match the leading market players in motorcycle category.

The functional ideation were initially based on bringing a novel experience in the usage of helmet. Storage and accessing helmet, visibility, airflow within, comfort factors related to weight & perspiration and integration of latest technology were pondered upon. Several ideas including an integrated controller for operations on a helmet, concept of fold-ability aiding storage and additional attachments were thought of.

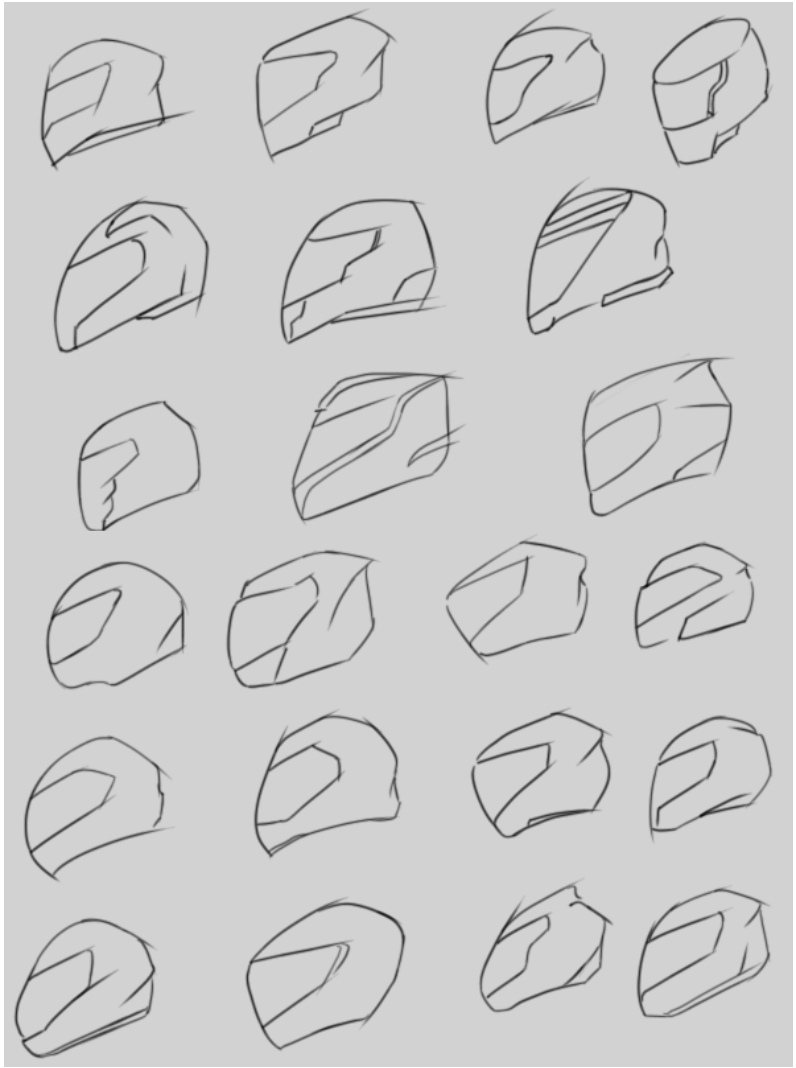


Fig.47: *Side view explorations*

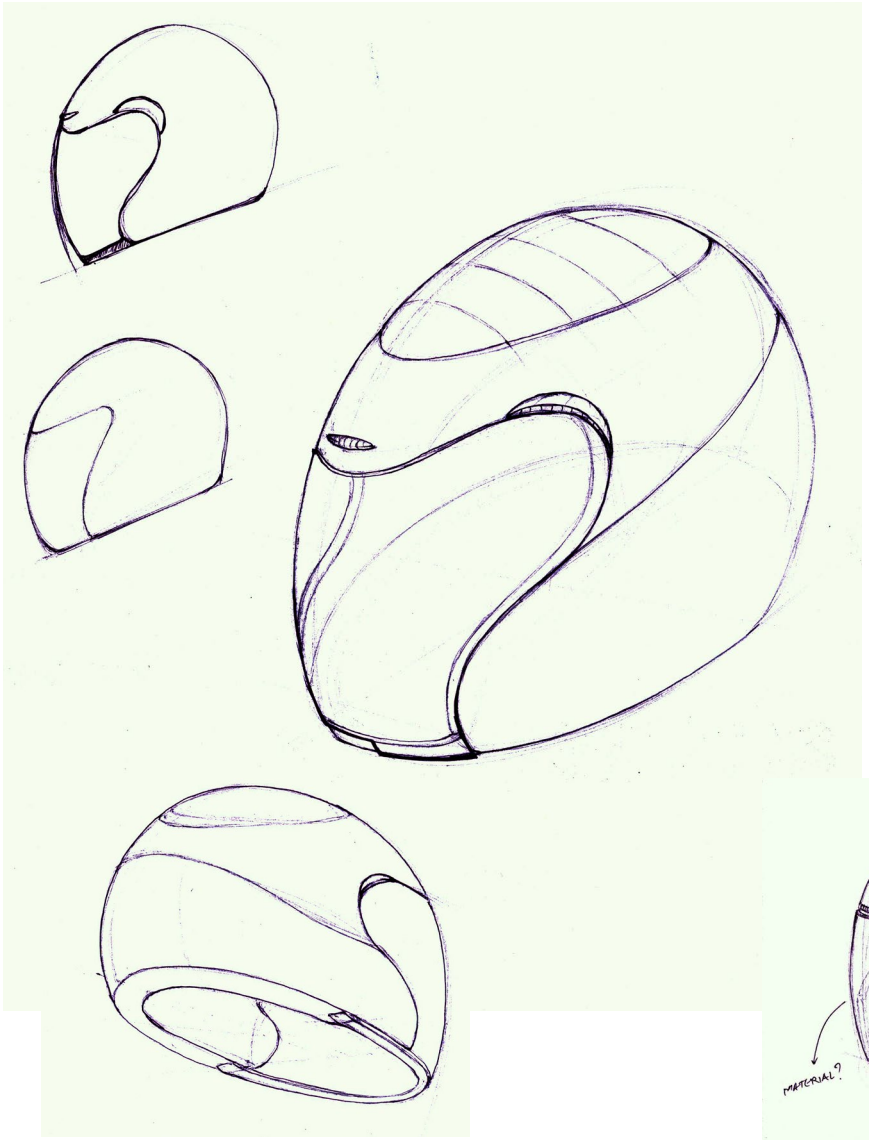


Fig.48: *Heads up display integration and overhead air intake*

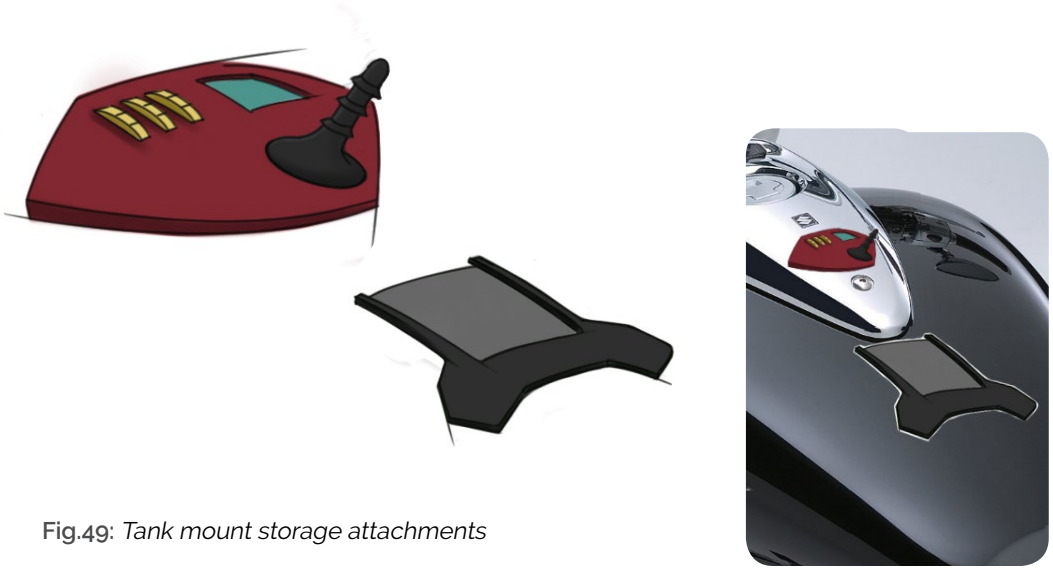
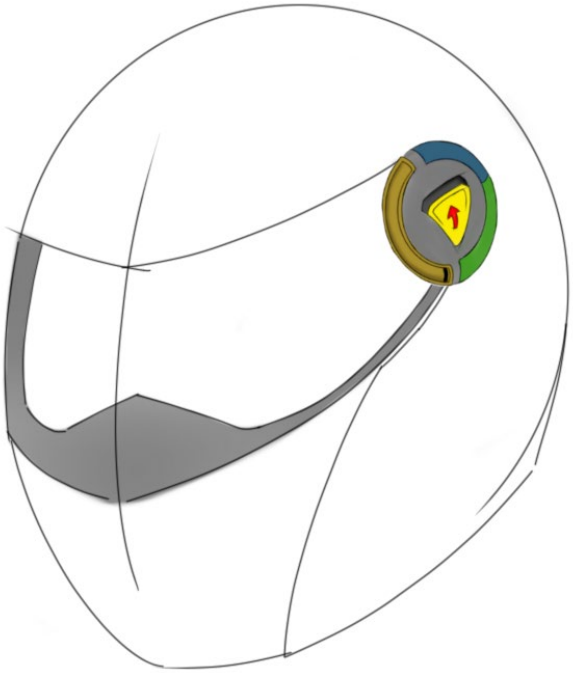
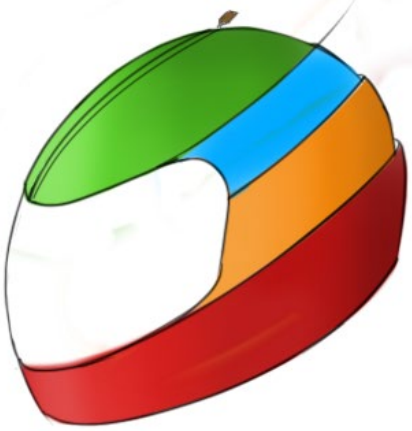


Fig.49: *Tank mount storage attachments*





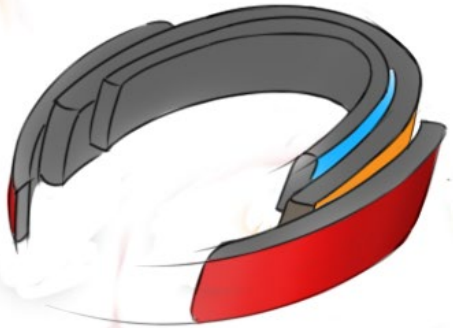


Fig.51: *Collapsible helmet*

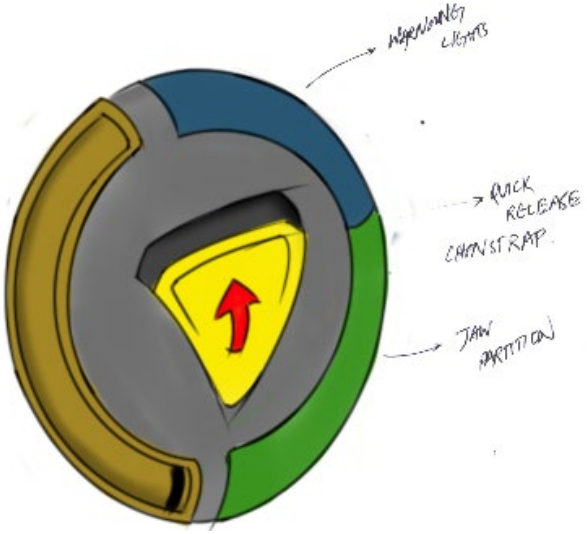


Fig.50: *Helmet with integrated controller & clip on chinstrap*

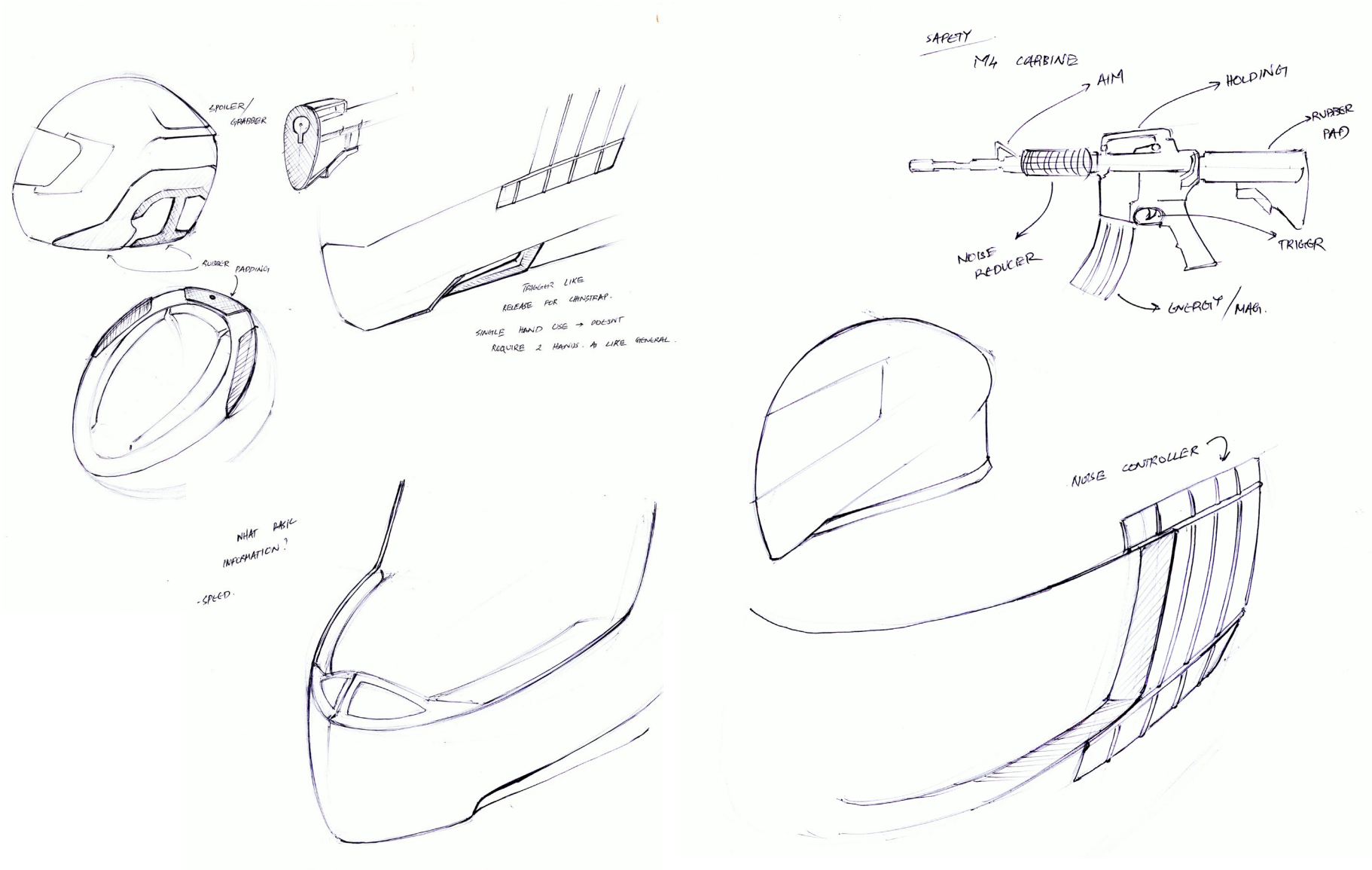


Fig.52: *Assault rifle M4 carbine (metaphor - self protection) inspired characteristics*

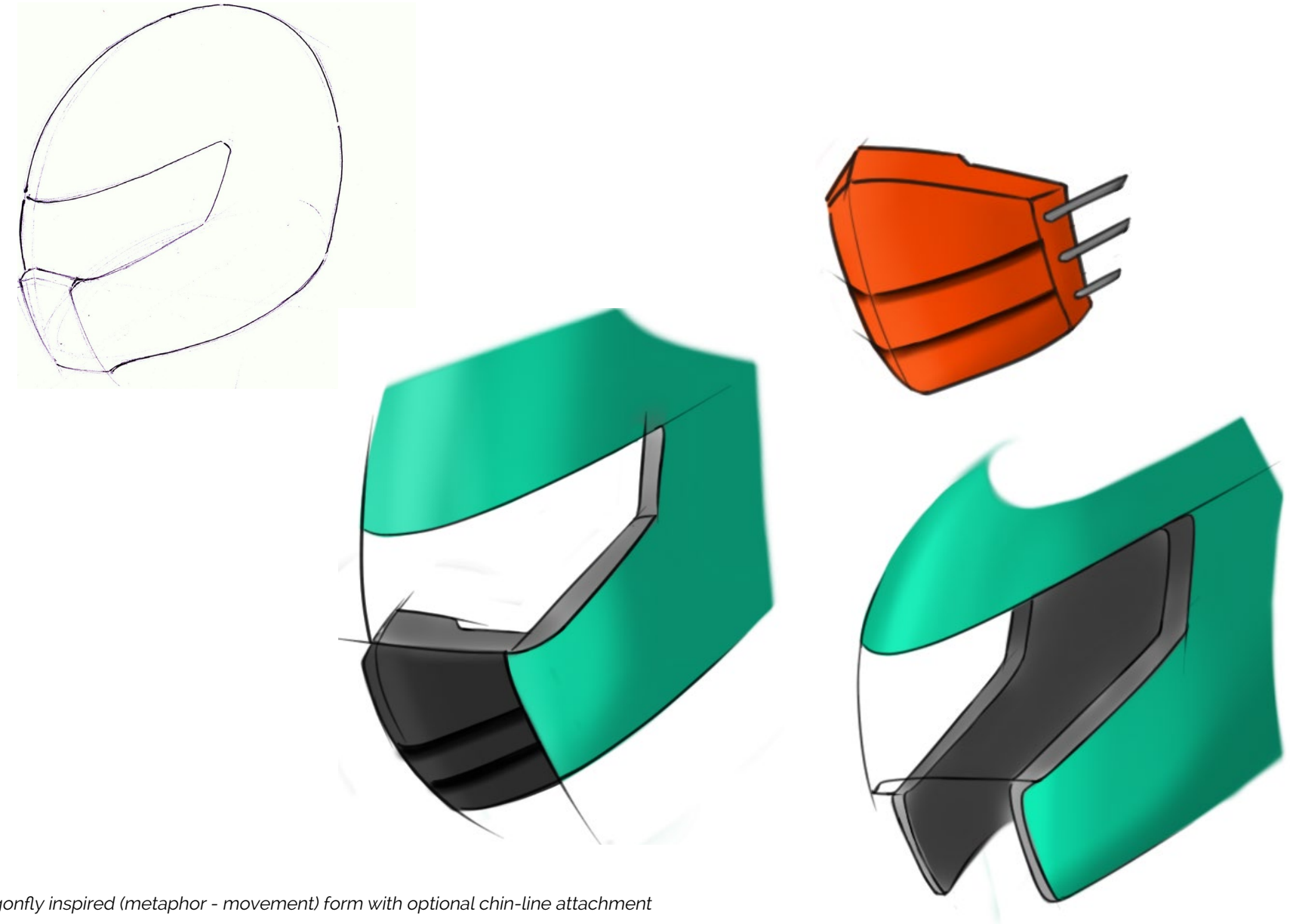


Fig.53: *Dragonfly inspired (metaphor - movement) form with optional chin-line attachment*

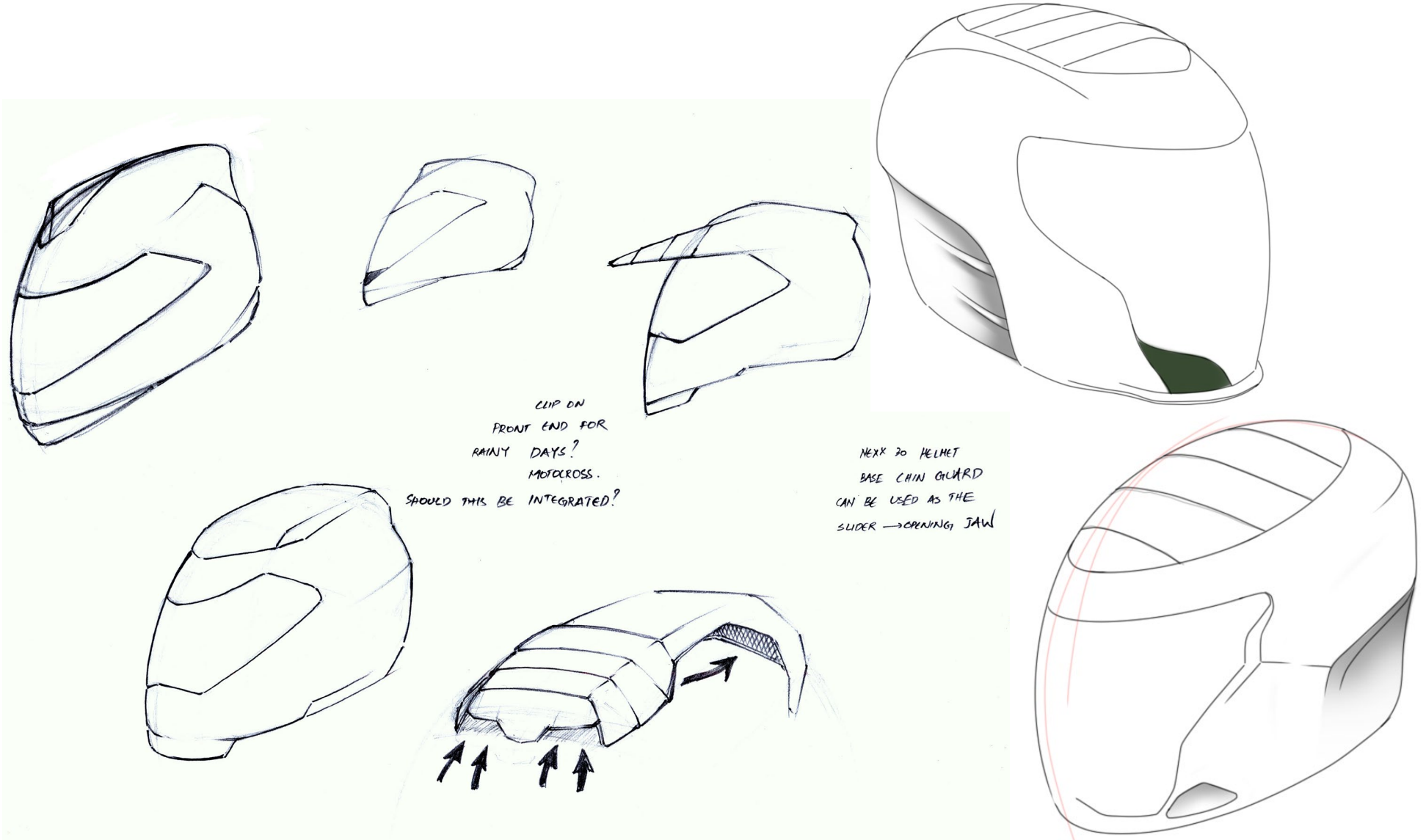


Fig.54: *Retractable motocross roof - better airflow, weather protection*

EXPLORATIONS - FUNCTIONALITY

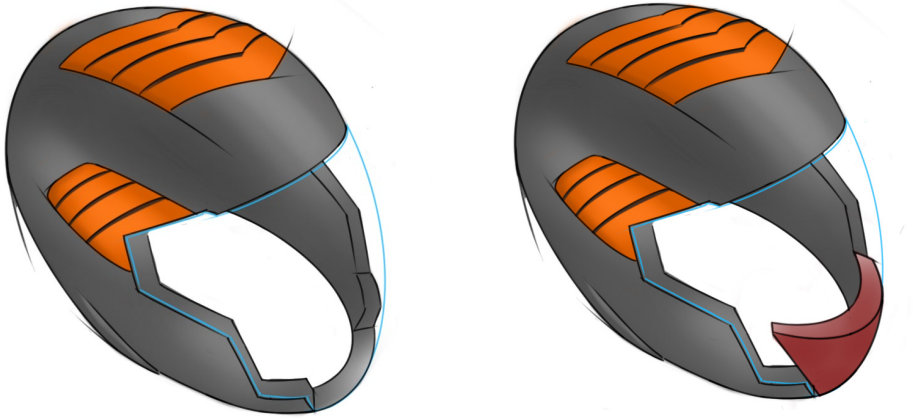


Fig.55: *Without HUD & HUD mounted helmet*

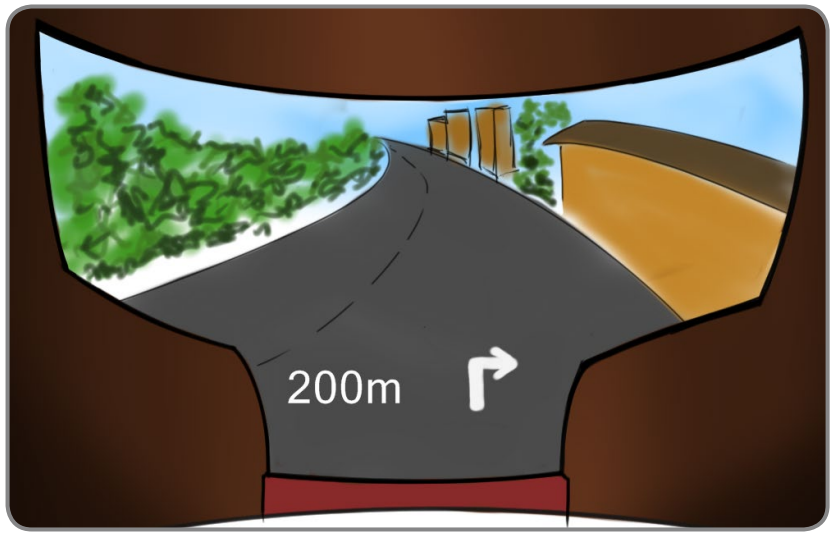


Fig.56: *HUD information display*

Idea I

The first idea cluster was lined towards utilizing modern display technology - Heads Up Display. Weighing up the touring requirements or reaching unfamiliar destinations in a city the modern technology of projecting information that is visible to the rider was thought of.

Currently riders rely on GPS functionality in their smart phones. Integrating the GPS functionality along with a display unit and rechargeable battery, the display unit was conceived as a separate unit to enable easy charging and could be mounted on the thin jawline of the helmet up front. The jawline is designed to accommodate the unit that provides information about the distance and direction of travel (Fig 55) . Information provided to the user was limited to the basic so as not to disrupt riding (Fig 56) .

The jawline was purposefully made thinner so that wearing the helmet limits the claustrophobic effect on the user, but increases visibility. The presence of a thin but strong jawline provides adequate safety too.

A retractable roof (Fig 57) was included in this idea which could be used at times of rainy weather for protection. It was inspired from the functional advantage of a motocross helmet, minus the drawback of batching wind while riding fast. When not in use, it acts as an overhead air vent. The air vents provided along the sides also sport the same design language as of retractable roof. Vents along the sides (Fig 58) are envisioned such that they could be operated individually, to control the amount of noise and wind received by the rider. They operate similar to AC vents in cars.

Additional attachments were thought of that would help in the safe storage of the helmet. They were envisioned along the lines of tank pads which are used as scratch proofing accessories for fuel tanks (A tank pad is an add-on which is permanently stuck using a strong adhesive) . These could be permanently stuck to any flat surface on the motorcycle and the helmet could be secured onto it. Number lock and push lock with key were utilized as security measures for the storage attachment.

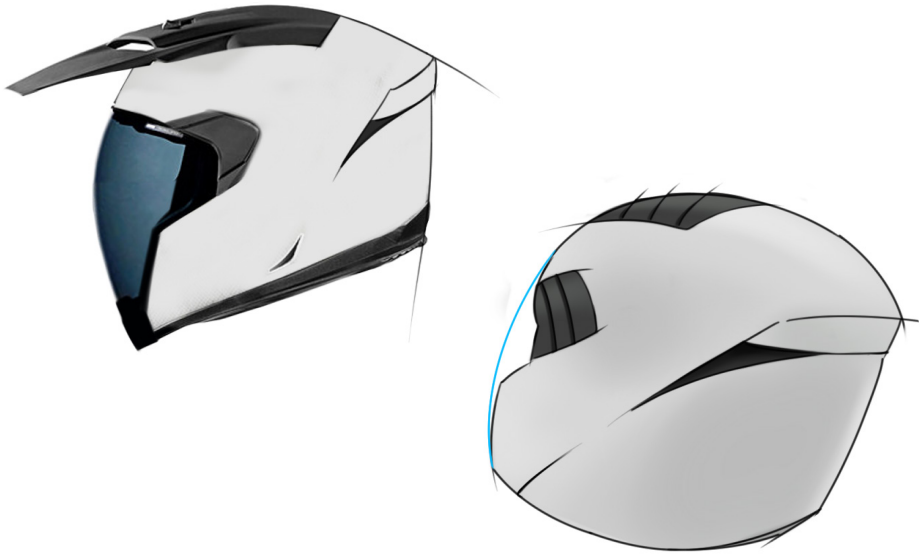


Fig.57: *Retractable roof*

Fig.58: *Side vent*

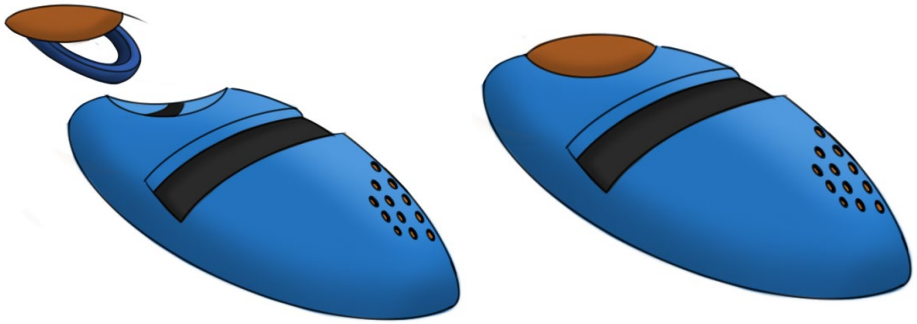


Fig.59: *Refined tank pad attachment*

The tank pad helmet storage was refined (Fig 59) as the one here. A major problem of helmet odour was also taken into consideration here. Due to sweating inside the helmet owing to the tropical climate, helmets are prone to develop an unpleasant odour after a certain period of usage. The liner within helmet could be washed to address the problem, but is not a feasible solution for every day. Hence the tank pad lock was devised in such a way that every time the helmet is clipped on to it, the device releases certain amount of fragrance that helps the user avoid the sweating odour. Aromatherapy can be adhered to and fragrances that help charge the mind up / help concentrate can be utilized.

The key that's released upon locking the helmet is in the shape of a ring, which makes the user face the difficulty of safe storage of key - simple. Upon locking the helmet, the ring that's ejected could be worn and at the time of unlocking user finds the key handy.

Idea II

Cluster two (Fig 60) involves parting jawline that holds a material similar to memory foam which helps in storage of the helmet. The concept of helmet locking itself to different parts of the motorcycle was brought out here. Keeping the shell intact over the critical area around skull, the jawline was conceptualised to part midway in front, allowing either parts to slide back on to the sides of the helmet.

The weight of the helmet is also a major concern and reducing the same would prove effective in acceptance of the same. Looking into the internal structure of the helmet, it was noticed that the inner EPS shell has remained the same solid structure from the inception. Honeycomb structure has the highest compressive strength under load / impact. Hence honeycomb structure made out of EPS (Fig 61) was suggested as the inner eps liner. The honeycomb structure proves to be lightweight at the same time offering better passage of wind through the cross section of helmet. The vents on the outer shell can be provided in a way that air flow can be maximised within the helmet.

Fig.60: *Concept II*

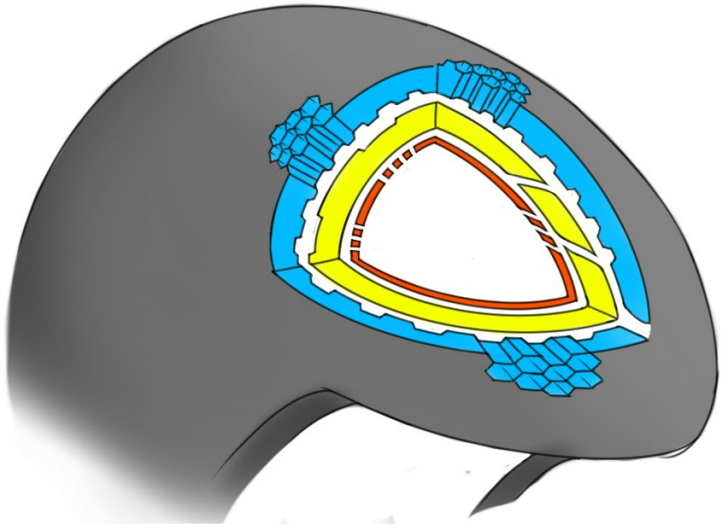


Fig.61: *EPS honeycomb inner shell*

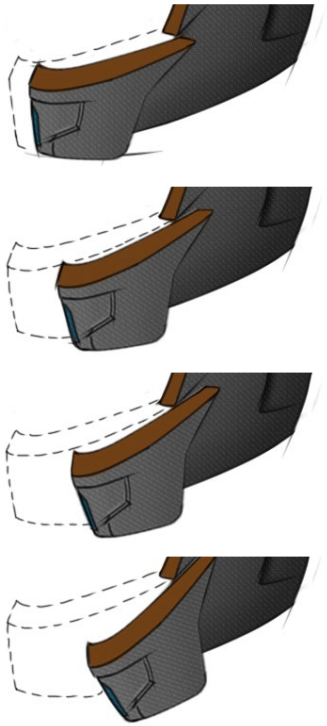


Fig.63: *Parting jawline*

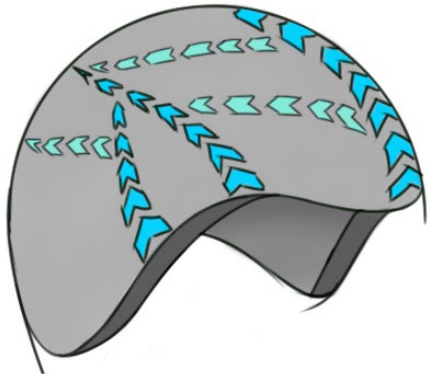


Fig.62: *Airflow pattern*

Fig.64: *Helmet attached to motorbike*

Airflow within the helmet (Fig 62) was divided into two main channels. The first set of channels that intake wind directly through the vents provided on the outer shell, and the second set of channels that help divert the first intake through the other parts of the helmet. The channels are oriented such that the frequent areas of perspiration is addressed to.

The parting jawline (Fig 63) consist of memory foam like material on the centre portion, helping the parting region to clasp around handlebar, tail-grab or any other part of the motorcycle feasible (Fig 64) . Concept of modular helmet is revisited here adding the functionality of storage along with reducing claustrophobia. The parting jawline also helps in opening up of the helmet in case it gets too hot or we've to ask directions while on the road.

Idea III

The final idea bundle (Fig 65) dealt with the pollution that rider has to face while being a city commuter. The jawline was reduced in front to provide better visibility and reduce claustrophobia to a certain extend.

It was observed that many riders in city travel with a scarf or handkerchief on their face to prevent themselves from dust and vehicle exhaust. The same idea was assimilated into a helmet wherein a pull out pin was provided to the cheek portion of helmet. The pin is attached to an air filter unit conceded within. When pulled out, it provides air filter fabric with elastic on either ends that comfortably fits on to face. The pull out pin can be locked to the opposite cheek line of helmet (Fig 66) .

Recent advancements in wearable technology holds promise in air purifier mechanism (Fig 67) that can be integrated with the helmet. The air purifier can be provided as an optional attachment that could be integrated to the jawline providing quality breathable air to the rider. A costlier proposition, but feasible down the years.

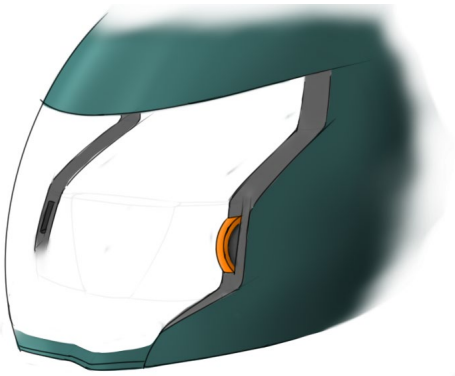


Fig.65: *Concept III*

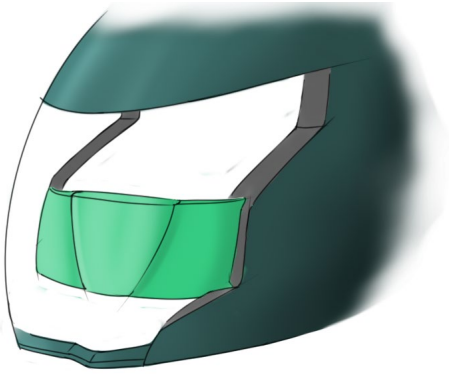


Fig.66: *Pull out fabric filter*

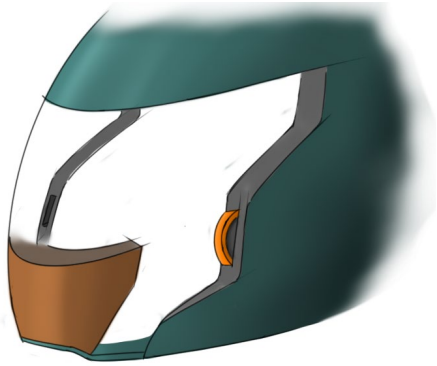


Fig.67: *Wearable air purifier unit*

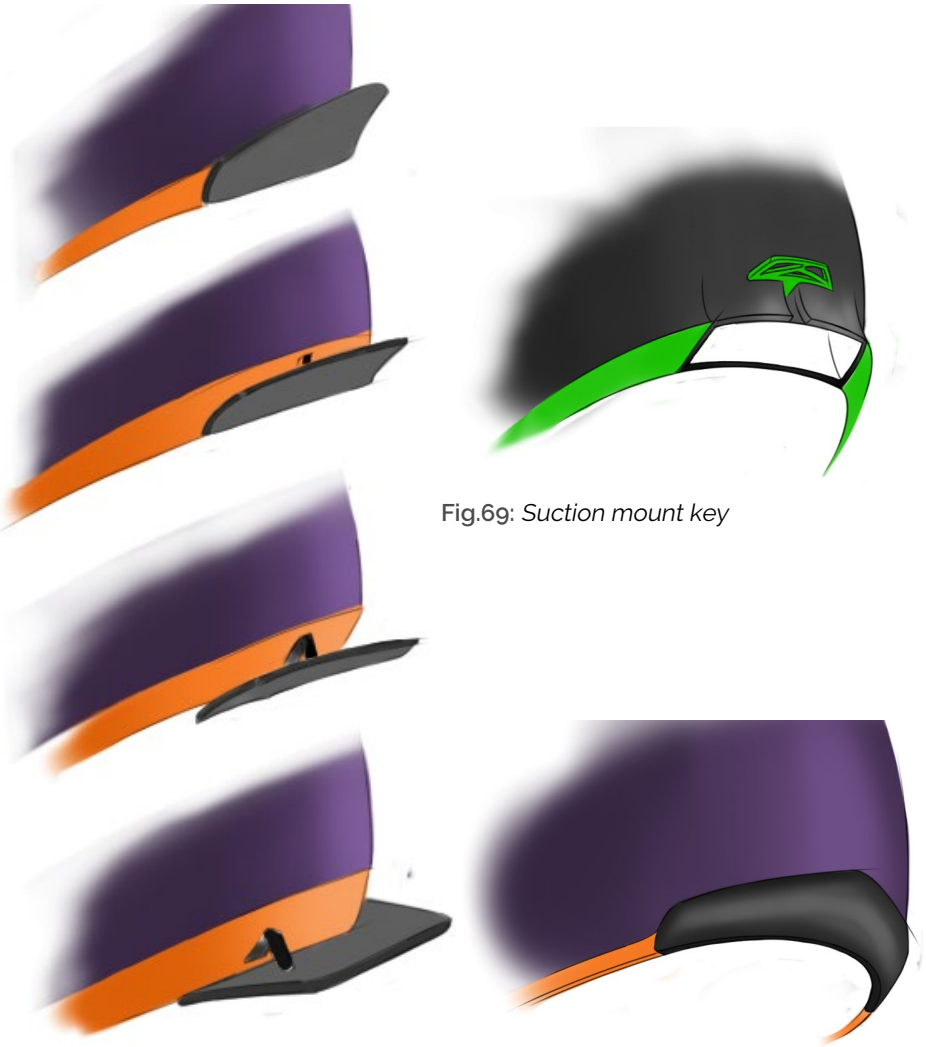


Fig.68: *Suction mount operation*

Fig.69: *Suction mount key*

Industrial suction mounts that could be employed on smooth flat surfaces can be utilized to attach the helmet on to the fuel tank or any other flat surface on a helmet. The rear end of the helmet has been modified to enclose a rectangular industrial grade suction mount that can be key driven for extra security (Fig 68,69) . This mechanism enables the helmet to be docked at any flat surface on the motorcycle with least effort. Similar mechanism can be found in the attachments of GoPro action cameras.

Incorporating this suction mount on the rear with the tank pad push lock at the front end of helmet would provide protection on either ends of a helmet. This was envisioned to prevent vandalism of a docked helmet. Leaving it arrested at only one point might prove not that effective in case of attempted theft.

Further considering the weight factor of the helmet, Kranium technology developed at RCA for bicycle helmets can be integrated to motorbike helmets with sufficient modification / precautions. The Kranium technology relies on using cardboard parts to recreate a shell structure that goes above the head to protect in case of an injury. It cannot be directly applied on to a motorcycle helmet as the speed in which a user travels & impact energy is high for the latter. Hence a padding / protection is provided using honeycomb eps shell beneath the Kranium with sufficient thickness so as to meet the safety standards of motorbike helmets (Fig 70) .

The inner shell design allows for a certain amount of air gap between layers inside the helmet. This also helps in channelizing and effective distribution of wind within the helmet.

As a formal language, the jawline and air vents (Fig 71,72) have been redesigned taking inspiration from the bone structures to provide material saving and reduced weight for the jawline, as well as, an asymmetric nature to the vents. They help in providing a distinct character to the helmet not previously observed in the market segment.

Fig.70: *Kranium & EPS honeycomb*

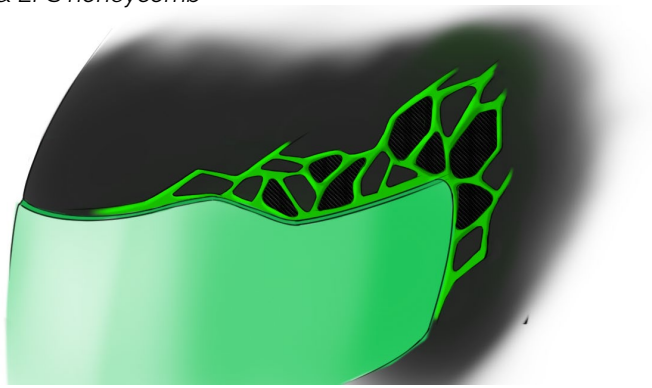


Fig.71: *Side vent*

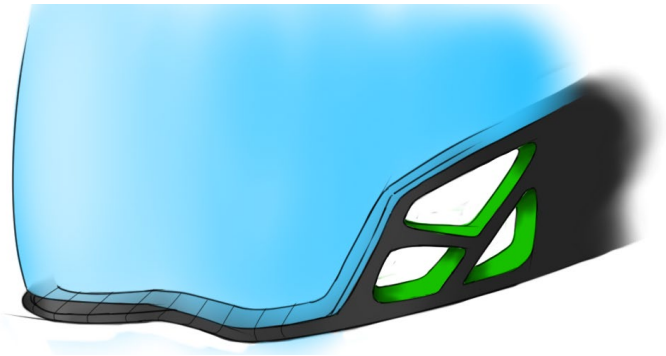


Fig.72: *Jawline negative space pattern*

Fig.73: *Kranium & EPS honeycomb*

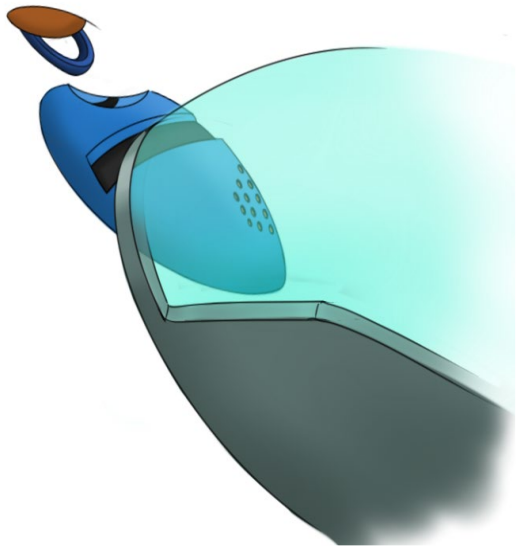


Fig.74: *Adhesive mount helmet locking*

Final Idea

Functional explorations taken forward

The design brief aimed at improving the accessibility and comfort of a motorcycle helmet. Functional advantages have the major say towards providing the same. Of all the different ideas that spurned out, few of the ideas were collated to better address the checkpoints in design brief.

The concept of Kranium (Fig 70) which reduces overall weight of the helmet, along with improving the heat insulation and air flow within the helmet was taken forward. The use of Kranium has already been tested and verified in bicycle helmets; hence this idea has more potential while piggybacking. The material used for the construction and further details are to be refined in the Final concept.

Effective storage of helmet is also a pressing problem for most of the users. Hence the two ideas of storing the helmet onto any flat surface, primarily the fuel tank (Fig 74) was taken up. The adhesive mount for locking the front chin area of the helmet and suction cup mounting at the rear end of helmet were selected as they ensure that the helmet is locked at two opposite areas.

It would make it difficult for anyone to steal the helmet as there are no free ends. Adhesive mount falls close to the existing attachment of tank protective pads seen in motorcycles and hence should not be alien. The functionality of suction mount (Fig 75) is well displayed in the capacity of GoPro suction mount that holds the equipment on motorcycle surface at over 100 kph. These ideas were taken forward, and to give a character to the helmet as such, various styling options were considered.

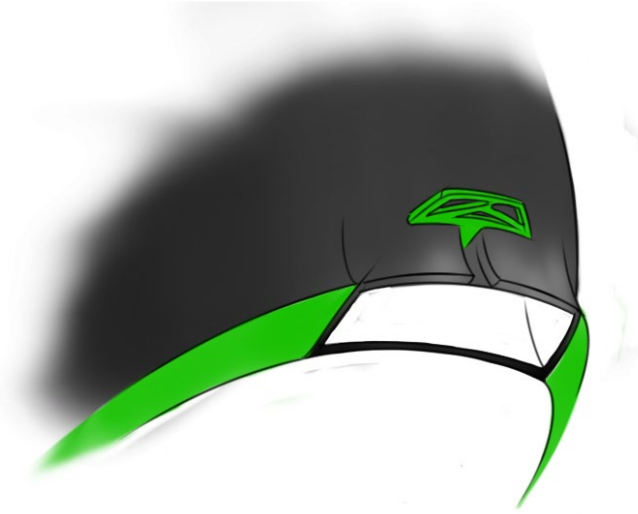


Fig.75: *Suction mount cavity on helmet*

EXPLORATIONS - STYLING

Styling Direction

After finalizing the functional advantages that should go into the motorcycle helmet, the attention was diverted to the style quotient required for completing the product. Upon discussion with guide, it made more sense to design the helmet catering to a particular genre of riders or a specific motorcycle manufacturer. Hence the attempt to give a character to the helmet was taken up, without which the product would be incomplete.

The styling explorations started with taking inspirations from two different cults of riders that aligned with two different motorcycle manufacturers. The two different approaches were aligned to the user persona created through the interaction with users. Café racer helmets for Enfield continental GT and racing full face helmet for KTM duke (Fig 73) were ideated upon. Their image boards provided the right amount of cues to customise the different aspects related to motorcycle helmet.

Fig.76: *Brand logos*

Image Board – GT



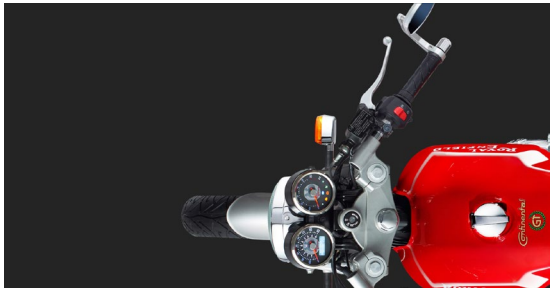



Fig.77: *RE Image board*

Image Board – KTM

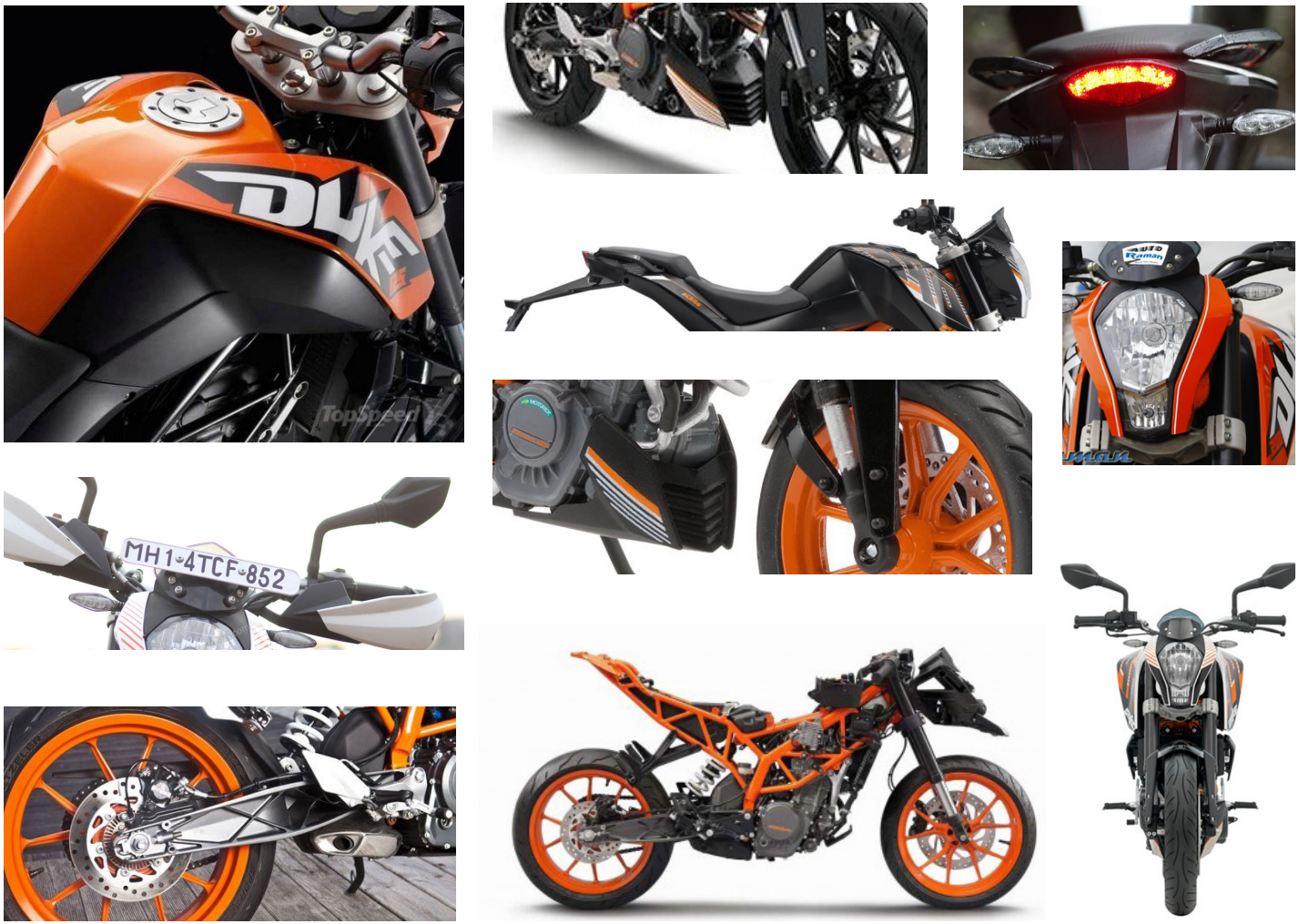


Fig.78: *KTM Image board*

Image Board – Automotive

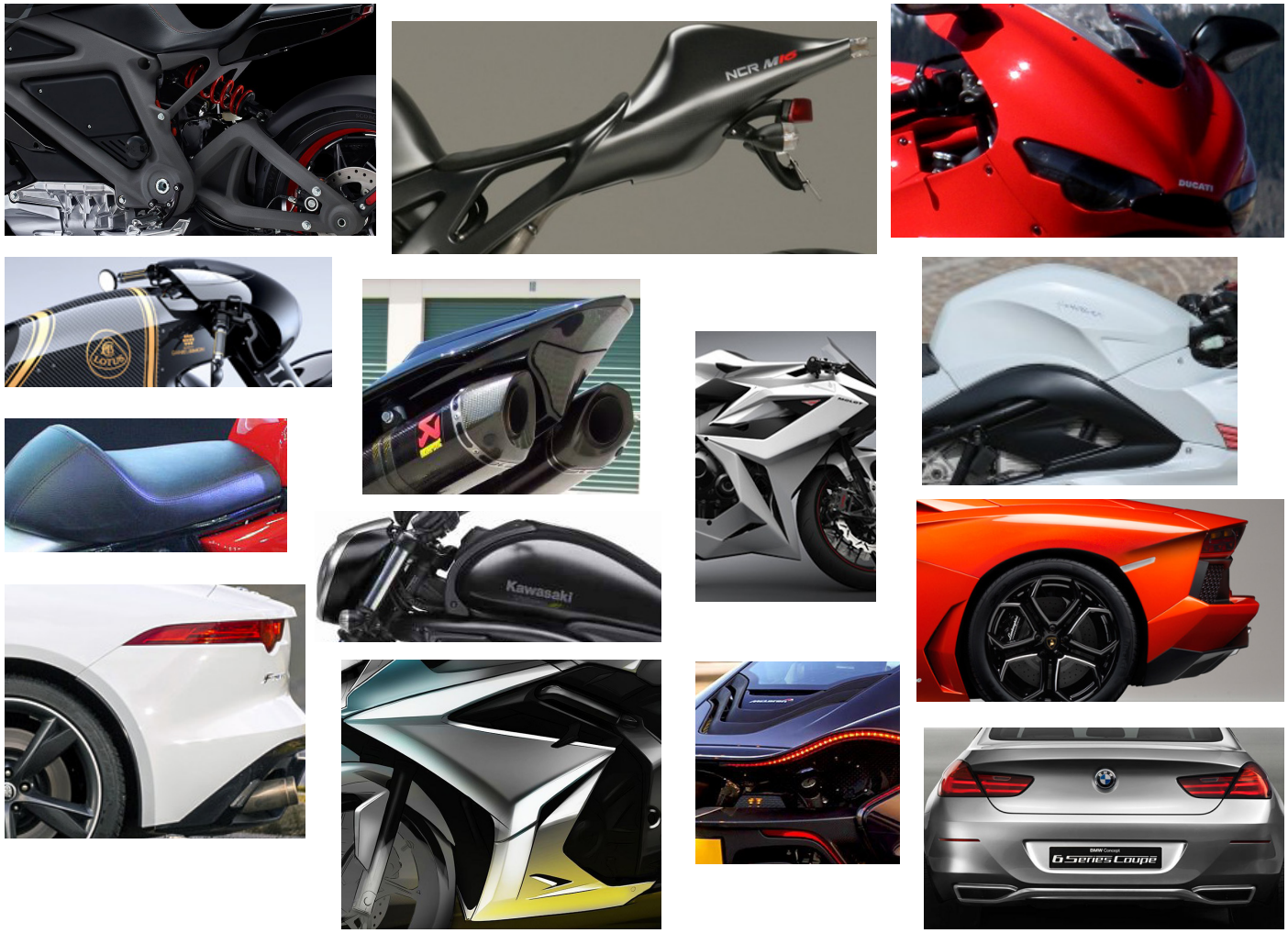


Fig.79: *Automotive Image board*

Idea I

The styling of the café racer was brought out as a subtle form that resembles the characteristic half face helmets that café racers generally wear. The helmet boasts a wider visor with curved edges that resemble the wide clear goggles of a café racer.

The jawline of the helmet (fig 80,82,84) has sufficient area covered for adequate protection, but has maintained the café racer full face helmet attribute of playing second fiddle to visor visually. Subtle variations in form were provided with adequate fillets without bordering any aggressive elements to the helmet. The characteristic dual odometer cluster (fig 81) provided inspiration for the dual air intake vents on the forehead of the helmet. Elements the carry the legacy of Royal Enfield were embedded on the helmet. RE branding blended with the front forehead vent.

The contour of the vents was created to blend with the dual odometers and circular logo. Characteristic pinstripes of Enfield Bullet were brought out to further enhance the overall form of the helmet. They add an element of craft, as pinstripes on Enfield fuel tanks are well known to be hand painted. An integrated wide rear

Fig.81: *Image cues*

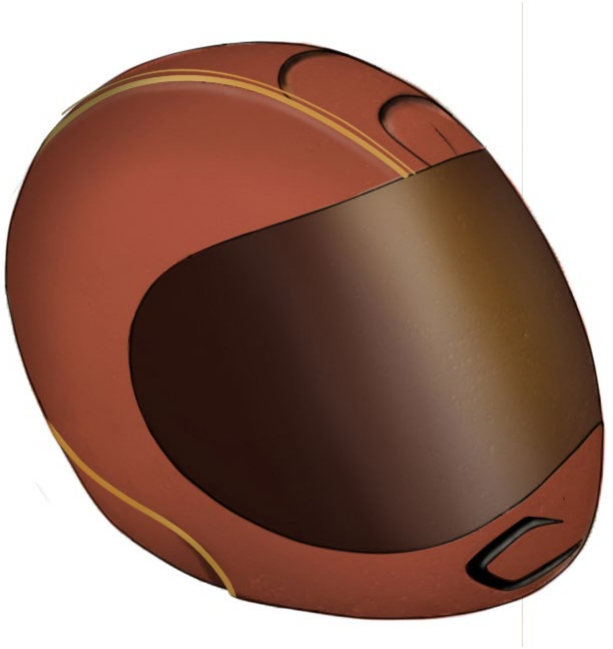
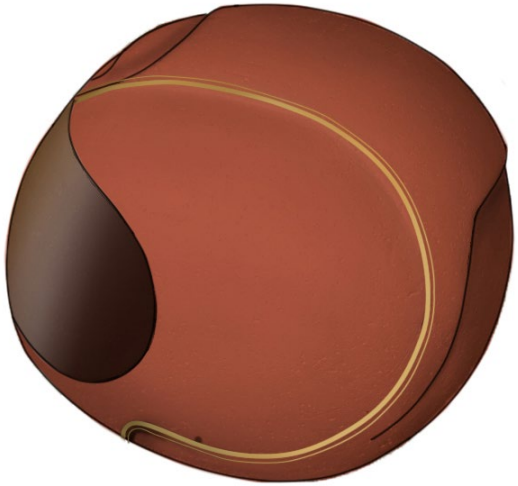


Fig.80: *Idea I*



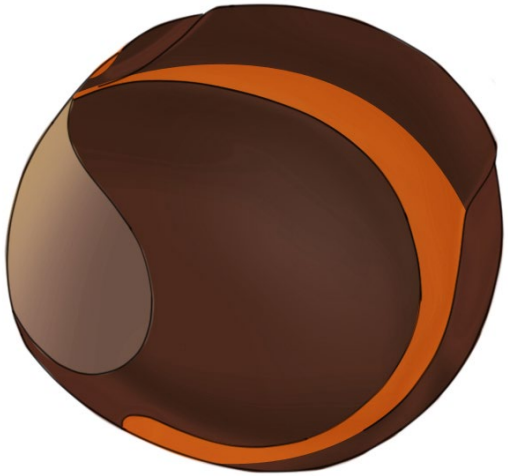


Fig.84: *color schemes*

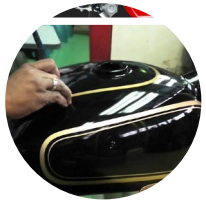


Fig.83: *Image cues*

vent was provided, along a depression that runs down along the back of the helmet. The pinstripes (fig 84) end in a recess near the base of the helmet. This recess doubles up to help user's thumb to comfortably fit in while wearing or removing the helmet.

Fig.82: *Idea I*

Idea II

The second iteration of café racer helmet(Fig 85,87,89) follows the rounded form with few prominent elements taken from the café racer GT. The form follows the contours (two curved lines that run through either ends of the forehead down to the back) that are present in the rear canopy of the motorcycle (Fig 88) .

Front air intake vents were inspired from the rear view mirrors and dual odometers found in continental GT (Fig 86) . The faint depression in the elliptical surface enables better air intake at front. Pinstripes are used in this iteration, but add a sense of speed and acceleration due to their positioning.

Five rear vents have been provided out of which four align with the stripes that run on either side of the helmet. The positioning and characteristics of these four rear vents have been taken from the cooling fins of the RE engine. The fifth vent at the rear end and the air intake vent at chin line have been inspired from the prominent rectangular frame that runs along the GT. Wide visor has been incorporated which follows the rectangular contours found in the GT.

Fig.86: *Image cues*

Fig.85: *Idea II*

Fig.87: *Idea II*

Fig.88: *Image cues*

Visor is fastened to the helmet using the Royal Enfield engine imprint profile to de-mark the helmet.

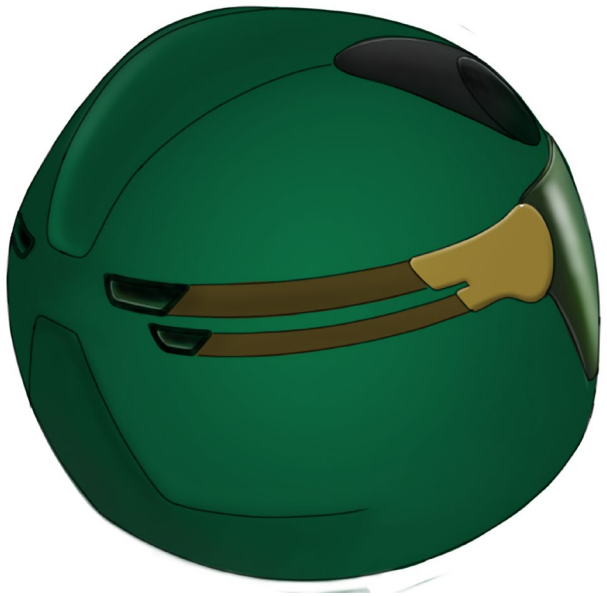


Fig.89: *Color schemes*

Idea III

The most prominent characteristic of a KTM motorcycle is the aggressive styling that involves the play of different surfaces and striking colour scheme that evolved to get associated with the brand. The trellis frame coloured in orange also stands out in almost all models of KTM.

The complexity with the play of surfaces was brought out in this iteration for the helmet (Fig 90) . Chamfered surfaces and edges were utilized to bring out the aggressive styling. Characteristic trellis frame was integrated on the part of helmet where impact rates were calculated to be high. The visor borrows inspiration from the overall contour of the fuel tank. Few of the front vents were integrated with the frame portion along the forehead.

A depression was provided along the front chin lines for better grip on the helmet using hands. The same was inspired out of the swing-arm present in KTM duke models. Ample air vents are provided around the helmet for smoother flow of air. The rear air vents are also integrated along the trellis frame demarcation.

Fig.90: *Idea III & Image cues*

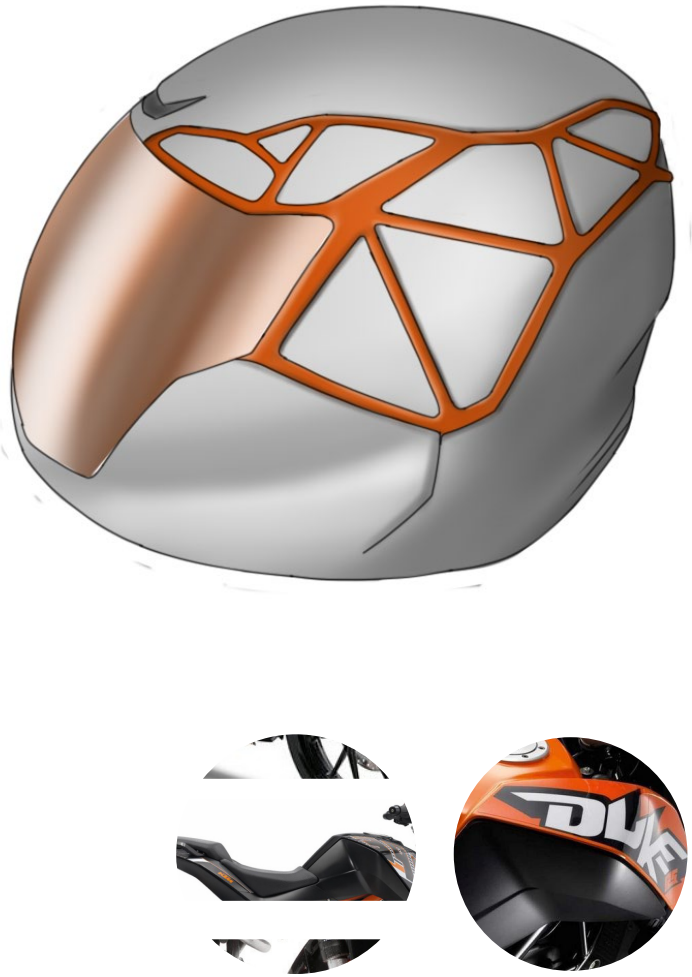
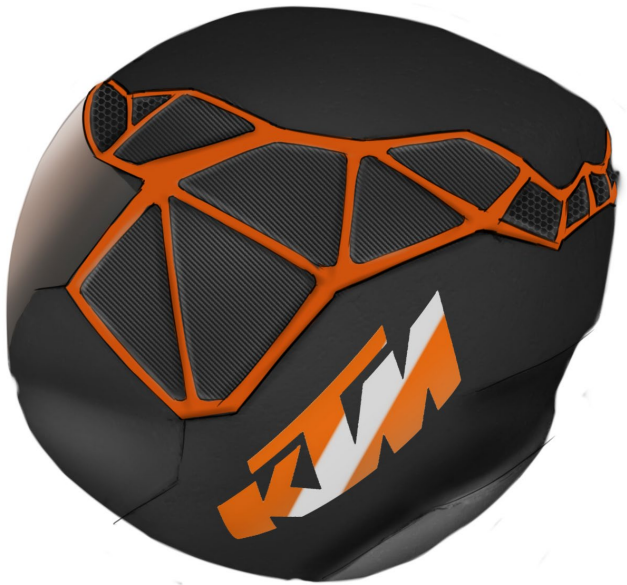


Fig.91: *Color schemes & image cues*

The rear end of the helmet has three different surfaces(rear and either sides that follow) which flow out to the chin area. The rear end was brought out considering the overall flow of lines on the KTM duke's body, right from the tank to the tail end (Fig 91) .



FINAL CONCEPT

Form Interpretation

Fig.92: *Final concept & image cues*

A helmet with character closer to the current two wheeler racing helmets, but emanate the aggressive KTM style, was thought of (fig 92) . The trellis frame retained as a major visual element was placed towards the rear end of the helmet. Minimal representation of the famous frame was employed in this design. Reducing the character of the frame to the basic core outer frame and connecting members within that went with the contours of the helmet. A recess inwards was provided with reference as to how the frame is integrated in the motorcycle. The frame was given chamfered edges with the top surface running along the rest of the helmet. At the rear end, the connecting members within the outer frame skeleton were envisioned to house the suction mechanism which would help arrest the helmet onto a flat surface. The frame was positioned towards the rear end of the helmet as this region is statistically the least subjected to impact during an accident. It also doubles up to provide visual prominence to the region on a helmet which in general is not visually highlighted.

The air vents on the forehead and on either side of the helmet sported the language of engine dirt guard. The forehead air vents were of V-shape. The cowls on either side of the forehead air vent houses the side plate and visor rotation mechanism. The cowls had a tapering end along the sides of the visor that attempted to reduce the visual prominence of the visor. The cowls blended along with the outlines of the visor having sharp lines that defined its form. The rear end of the cowl blended with the top and side surfaces of the helmet connoting the flow of form towards the tail of the helmet. The air vents along with the cowls were defined using sharp lines with minimal radii manipulation to accentuate the aggressive style which also denoted fast movement. The visor had prominent influence from the headlamps of KTM as they both relate to as ' faces' (Fig 93) . The narrowing down of the overall shape before the sharp drop of outline to the base of chin area, attempted to accentuate the visual language of forehead air vents. Unlike the sharp lines that denote the headlamp of the motorcycle, the visor was given considerable amount of radii manipulation as it interacts with the user both in terms of vision and contact.

Fig.93: *Color schemes & image cues*

The rear air vent on top surface ensures smooth exit of air. To characterise an end, tail lamp outlines in KTM were observed for creating this vent. Either ends of the air vent were curved inwards to align with the helmet's top surface. Major part of the vent runs parallel to the rear end of helmet denoting a tail or end section. The two vents on either side of the helmet were inspired from the swing arm of KTM. The border of these vents was such that they denote a forward motion from the side view of the helmet. The two air vents on the jawline were suggestive of fairings on a full-faired motorcycle. They were similar to the protective edges of the headlamp. They sport similarity to the contour of visor and denote sideways movement from the centreline of the helmet. This detail was explicitly done to bring out the motion of an object cutting forward through the surroundings / air.

Scaled Model

Working with automotive clay was chosen as a mode for the final deliverable (Fig 94) for the project. Since the project involved styling of a product as a major factor, clay was chosen. Expert guidance was provided, courtesy of Mahindra Design Studio. The clay used in modelling contains wax and sulphur. The characteristic behaviour of pliable nature when heated and retaining solidity when kept in room temperature requires an industrial oven. The clay comes in billets and is warmed up at 50 degree Celsius intermittently for an hour before application.

The tools used in the process included Rake (used in rough scraping off of clay) which comes in straight edge and curved edge, Chokkaki (used in scarping clay into flat or curved surfaces) , Triangle/ Both side/Oval rake (to be used for minute details / surfaces difficult for normal Rake) and finisher(to finalize the shape) (fig 95-100) . Wire tool is used in detailing work on the clay. Eventually Steel is used to smooth the surfaces. It is made as thin flexible sheets in order to smooth surfaces with curvature too. Different types of clay tapes were also used along the process. Clay tapes leave no adhesive marks upon clay surface upon removal as it has soft adhesion. Hence they can be

Fig.94: *Final concept clay model*

Fig.95: *Rake*

Fig.96: *Chokkaki*

Fig.97: *Finisher*

Fig.98: *Triangular rake*

Fig.99: *Both side rake*

Fig.100: *Oval rake*

Fig.101: *Clay billet & first surface*

Fig.102: *Applying clay*

Fig.103: *Rough craping*

Fig.104: *Shaping clay*

re-applied few times on the clay surface. They are used to plot key line drawings or for shape adjustment while working. They come in different colours and thickness.

Every clay model requires an armature upon which the clay is applied. Generally armatures are made up of a wooden or iron frame which is covered with Styrofoam. To model the helmet, an armature was made completely out of high density Styrofoam. Necessary details were created in the armature which helped in easier application of clay as there was a visual understanding of the details. The entire model of helmet was divided into three parts(according to different surfaces) and clay was applied. Visor was the first part where clay was applied (fig 101) . Heated clay was applied on to the surface of armature using hand (fig 102) . A necessary workable thickness of at least 25 mm of clay has to be applied on the surface. Since the visor and side cowls jut out a little from the main helmet surface, this entire area was first roughly modelled. After application of clay and basic shaping using fingers, hack saw blade was used in scraping off (fig 103) the excessive material to achieve very basic shape. Next, Rake and Chokkaki tools were used to further smooth the surface (fig 104) , after which Steel flexible sheets were used to fine the clay model. Tapes and knife was used to draw and mark outlines on

the model.

Next, clay was applied on the rest of the surface barring the area where trellis frame was present. This surface had vents to be created for which Triangular rake was used. Another technique which was used while creating the forehead vents was to create a rectangular template (fig 107) out of styrene. The surface of styrene was then smoothed with emery paper. Heated clay (preferably at 70 degrees) which feels almost molten was then applied on a flat surface and the template was drawn from one end to the other, thereby making the required cross section in clay. This cross section was then applied on the model to create repetitive ridges. It saved time and also proved effective & consistent.

The last area modelled was the rear end. The trellis frame was created using the same method above . After creating the rear end clay was placed in between the connecting frames. Masking tape was stuck over the frame member to prevent clay being accidentally applied (fig 106) . A rectangular block of clay was made within the frame which was later shaped using hacksaw blade, Rakes and Steel sheet. Necessary details were added with knife. Towards the end, in order to achieve good finishing, clean cloth dipped in paint thinner was gently rubbed on the clay surface (fig 108) .

Fig.105: *Rough form*

Fig.106: *Creating ridges*

Fig.107: *Template for ridge*

Fig.108: *Finished surface*

Fig.109: *Clay model at DDS 2015*

Helmet Detailing

The Computer Aided Design modelling undertaken in this project allowed me to explore a different approach altogether. The regular schema of things would require the ideation sketches refined, which then leads to the final concept / design. The final concept is then CAD modelled and a scaled model / prototype is created. During the execution of this project however, the final design intended to provide a character to the functional capabilities drawn out. The KTM character was refined through sketches which were then created in high density Styrofoam. The final Styrofoam model was then used as the base armature upon which clay was applied and the character brought out.

The clay model was CAD modelled using the principle of photogrammetry (Flg 110) . It is the science of making measurements from photographs, wherein which exact surface points are recovered from photographs. A special case of this principle called stereo-photogrammetry estimates the 3D coordinates on an object made in different photographs taken from different positions. Similar process was followed in modelling

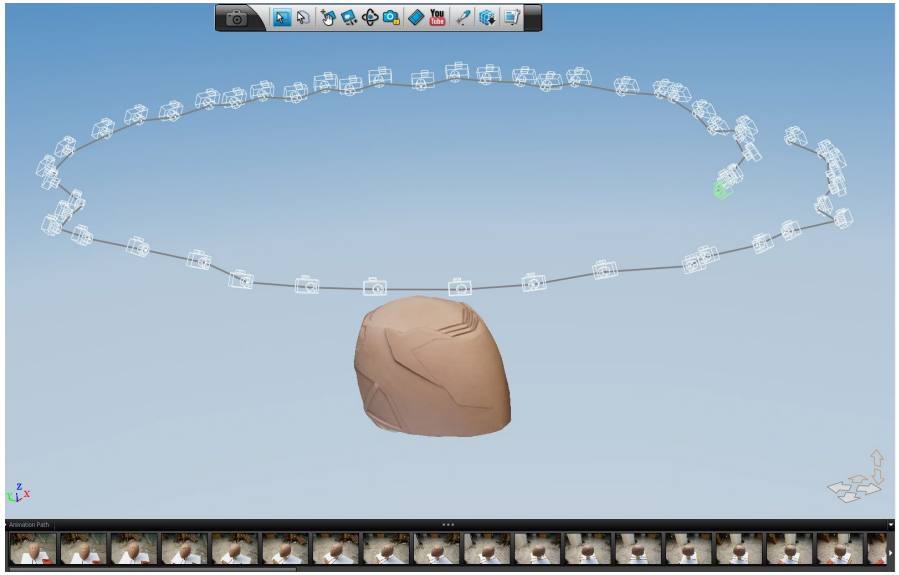


Fig.110: *Photogrammetry modelling*

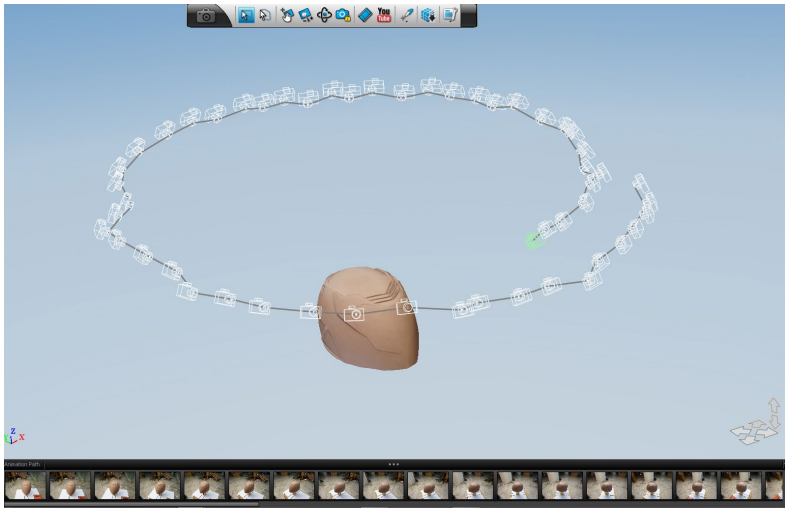
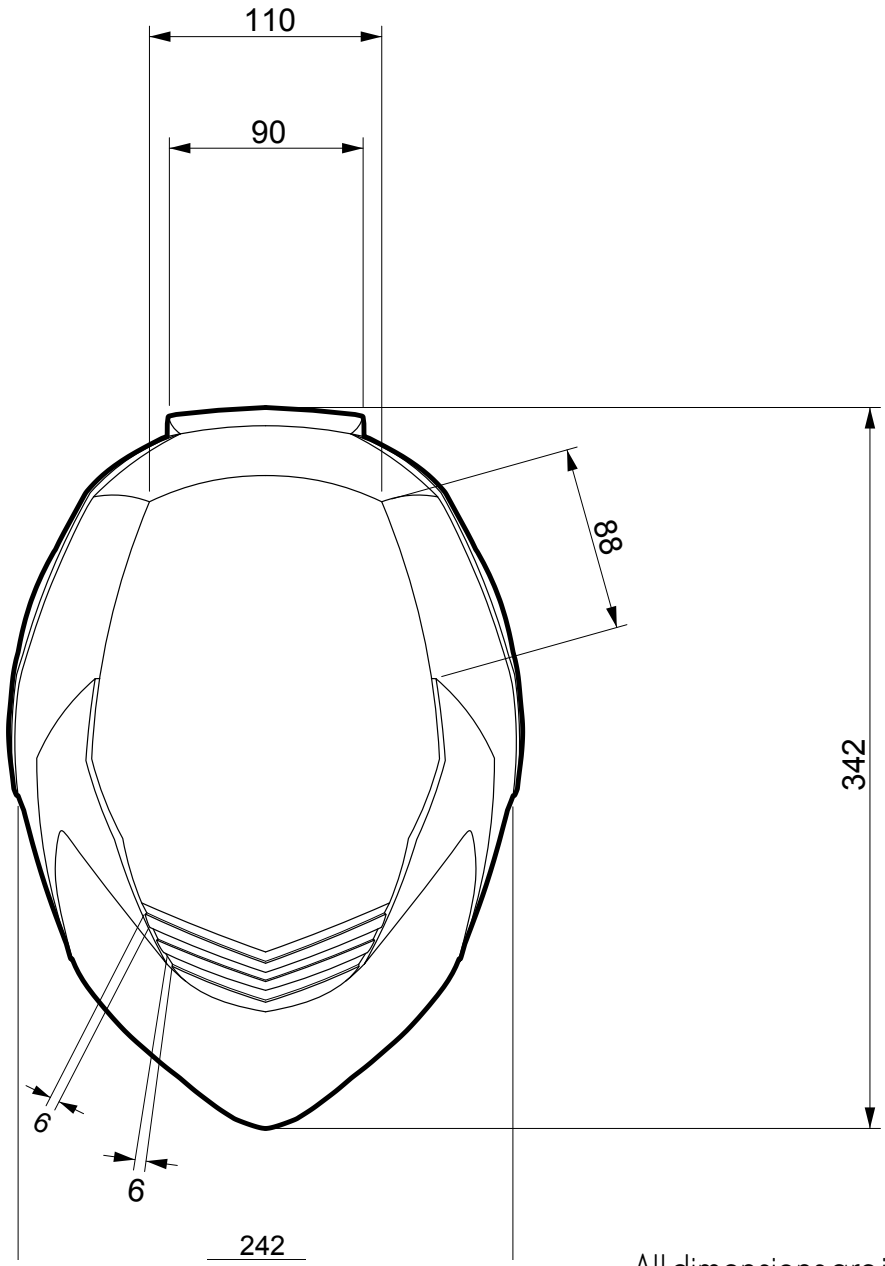
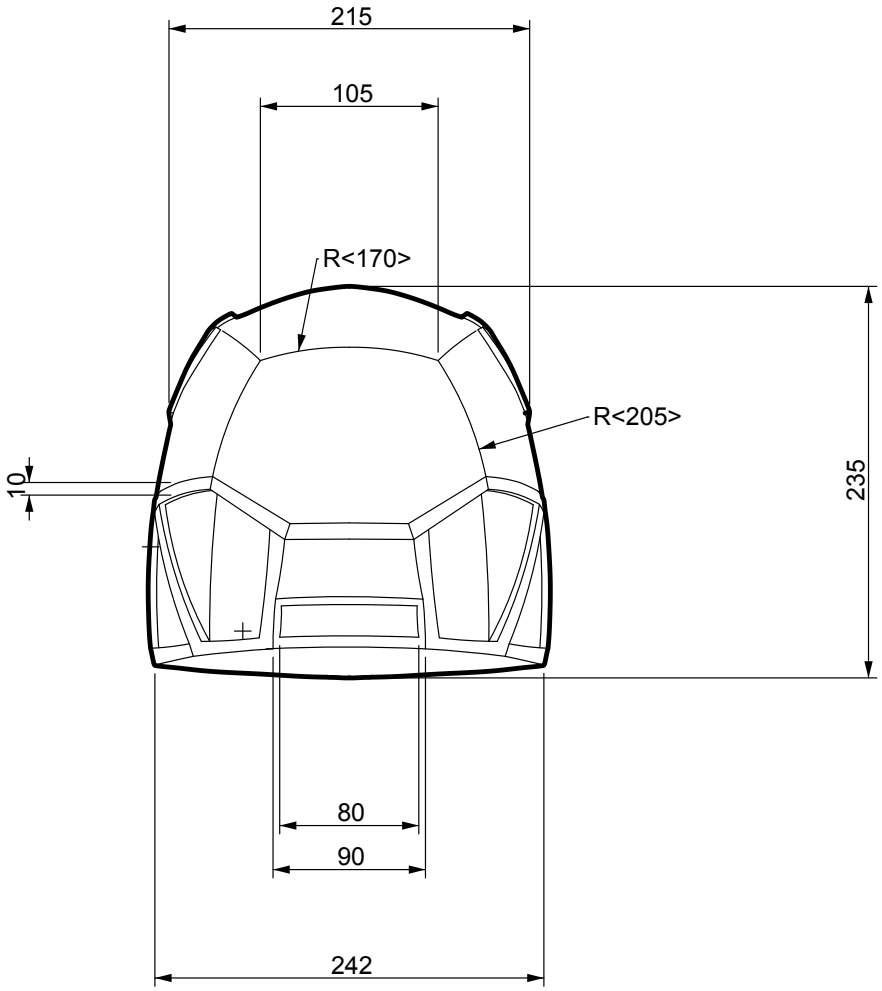


Fig.112: *Adobe 123D screenshot*

the KTM helmet. Photographs were taken from different points around the finished clay model (360 degree) (Fig 111) at different elevation and angles. Approximately 25 to 30 photographs were taken in each elevation to complete the 360 degree. These photographs were taken into Adobe 123D software (Fig 112) and stitched together using the principle of photogrammetry. The output of the same was refined using Maya, which delivered the final surface for rendering. The drawings of the same are outlined ahead (Fig 113-116) .

Fig.111: *Photos for modelling*





All dimensions are in millimetres.

Fig.113: *Top view (left) & rear view (right)*

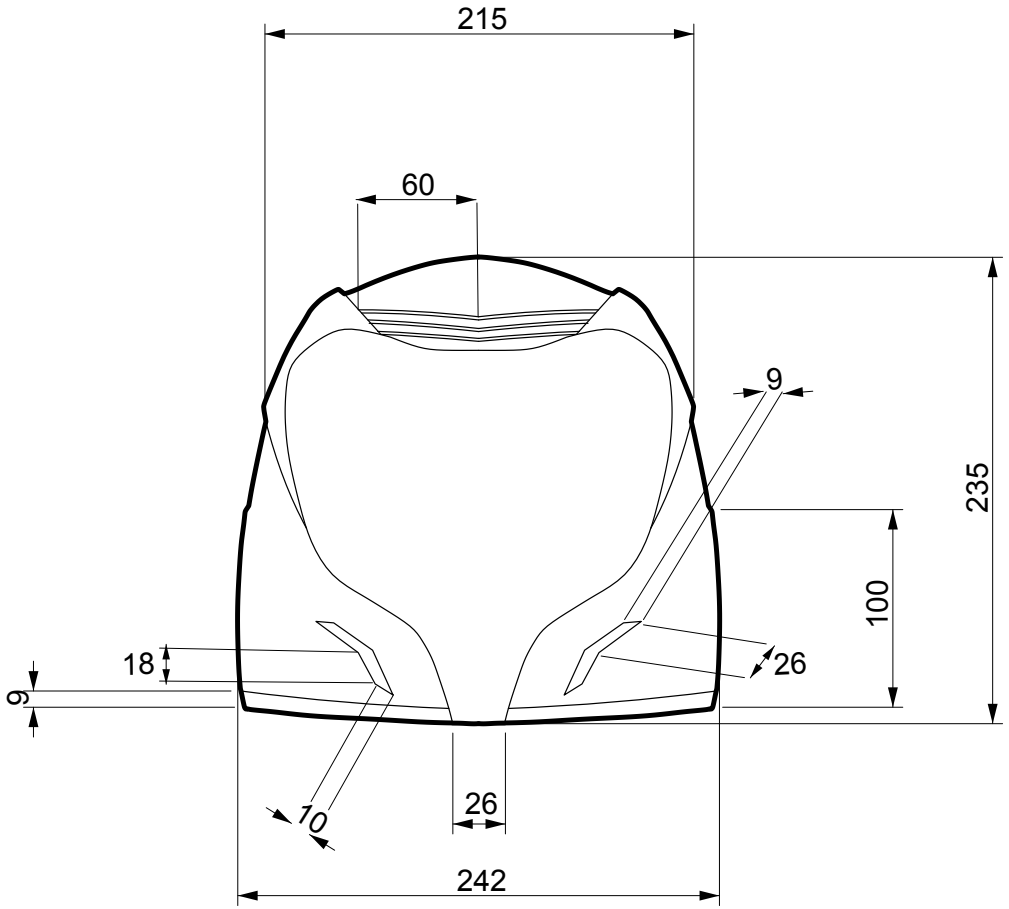


Fig.115: *Front view*

All dimensions are in millimetres.

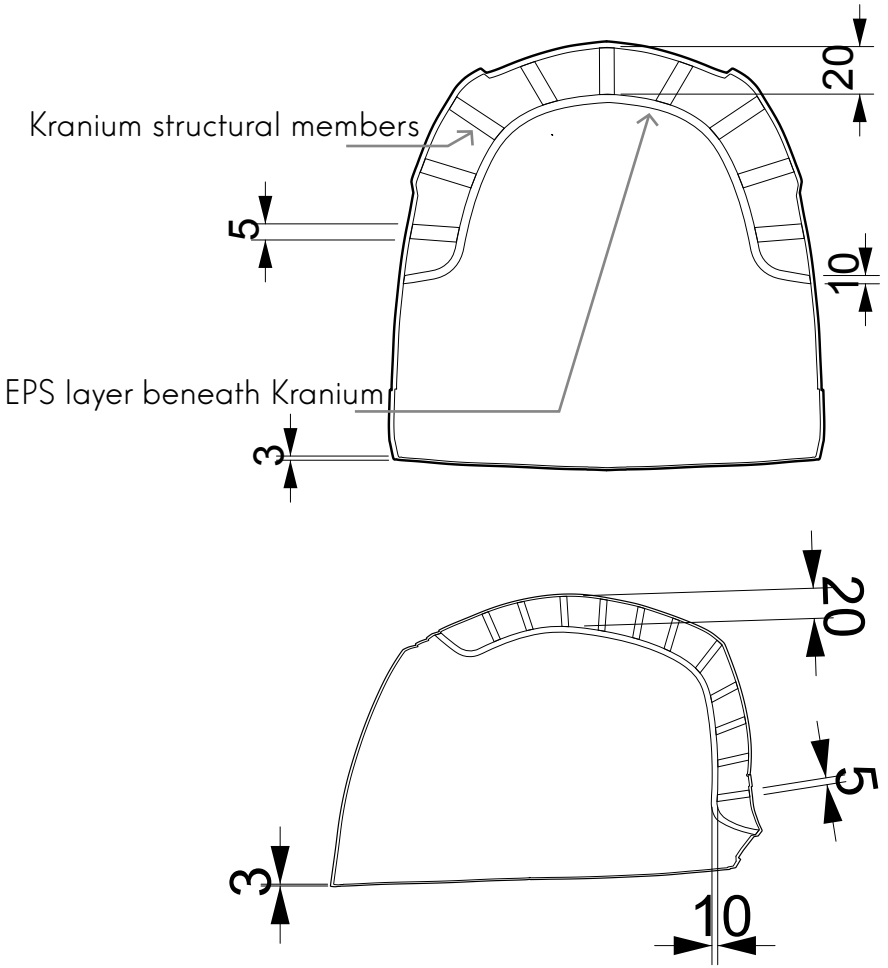


Fig.114: *Cross sectional views*

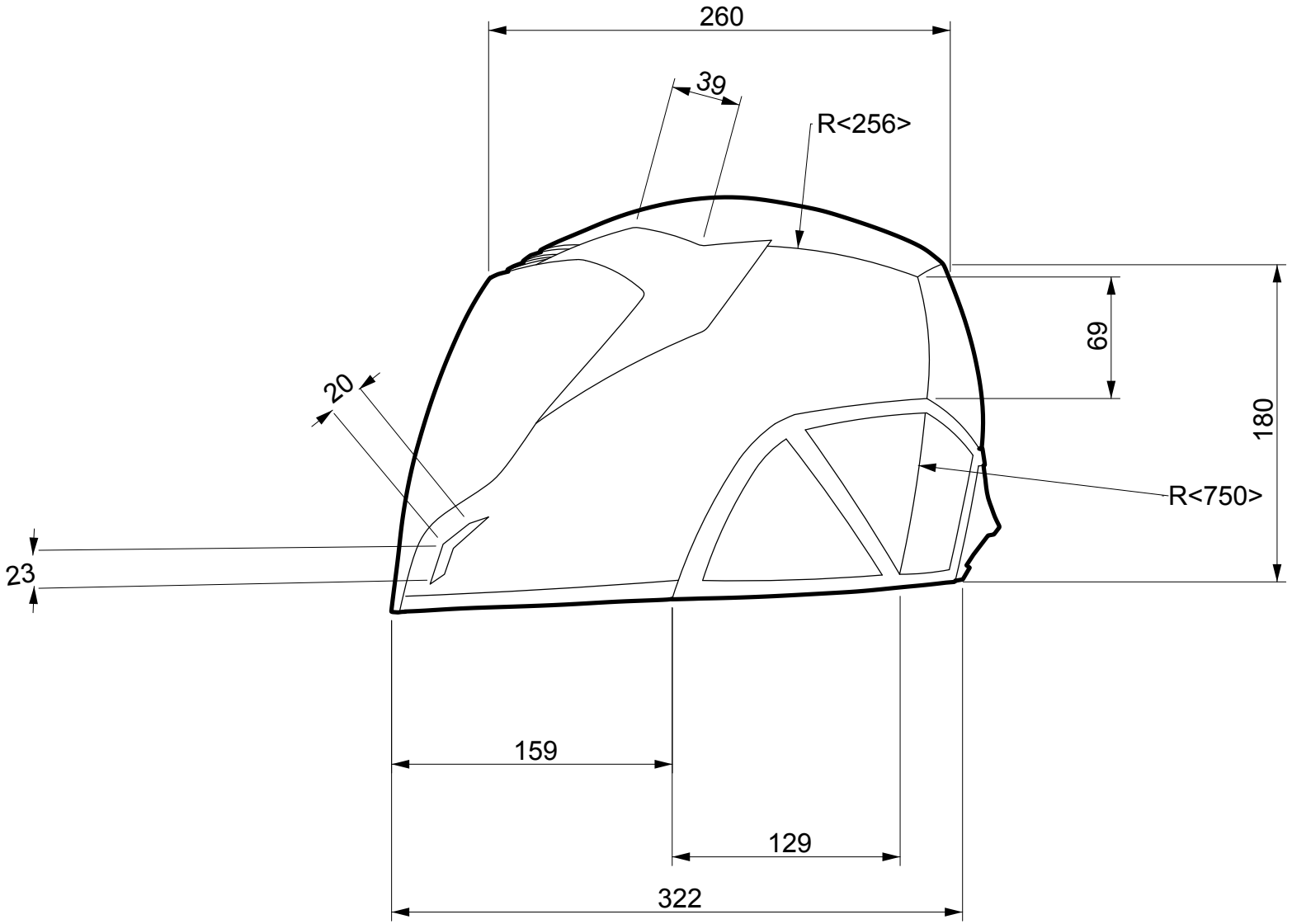
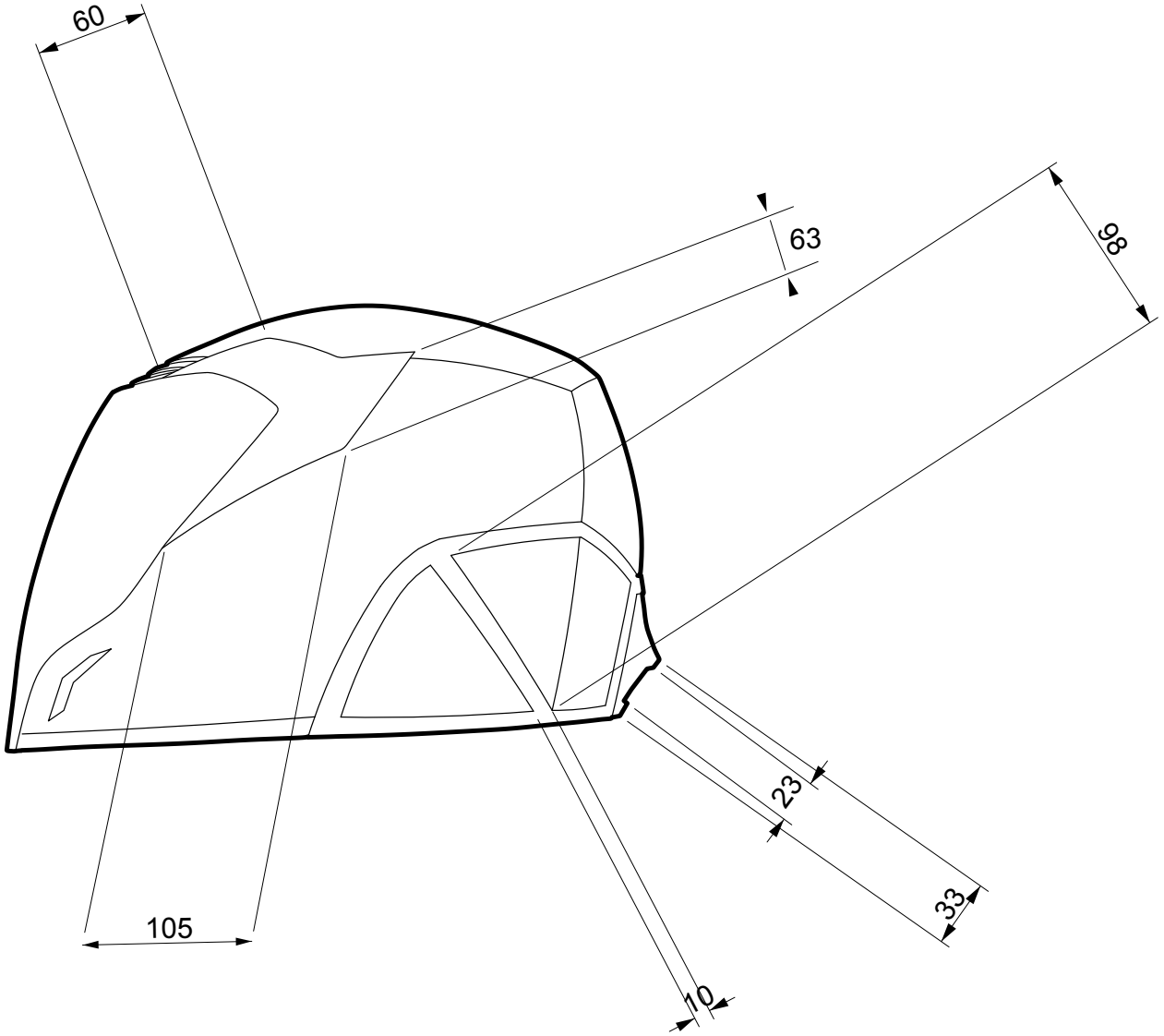


Fig.116: *Side view*

All dimensions are in millimetres.



Side view dimensions continued

All dimensions are in millimetres.

Combined unit: Motorcycle & Helmet

The final concept of KTM inspired (fig 117-119) motorcycle helmet looked at integrating the functional concepts of self-locking mechanism and redesign of inner shell. The advantage of redesigning the inner shell aimed at reducing the weight of the helmet and improving the heat insulation & airflow within. Helmet along with the duke series of KTM motorcycles were also visualized to fathom the idea of helmet and motorcycle as a unit Details imbibed for the helmet are described ahead, which serves the idea of helmet and motorcycle considered as an entity.

The outer structure of the helmet consists of following parts. A major shell that provides the first layer of protection, a visor to protect the face and provide visibility, slide covers for the front air vents, side plates under which the visor rotating mechanism is housed. The major shell which comprises of most of the outer structure is to be made out of thermo-injected plastic (ABS or polycarbonate) as the surface involved has a certain level of complexity. Reinforced fibreglass could also be used an alternate option but the latter being hard comparatively to injected plastic,

Fig.117: *Concept rendering*

Fig.118: *Alternate views*

Fig.119: *Color scheme II*

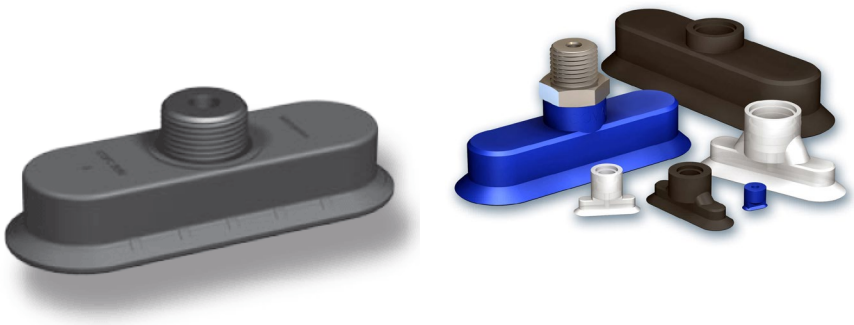


Fig.120: *Coval suction cup*

the characteristic of flexing would be marginally low. Hence ABS or polycarbonate would be more suited as it relates to the way the inner lining is structured. The fibreglass shell being more rigid does not flex much and would result in more force being exerted on the inner liner by the head. Carbon fibre could be utilized as an alternative but would prove to be cost intensive.

The outer shell has three forehead vents and two chin side vents which can be closed upon requirement. The rear vents include two side vents and a top vent. The top vent has an option to be closed whereas the side vents doesn't have. The rear end of the shell has a cavity in which the suction cup is to be mounted in. The suction cup used in the rear end of the helmet is of industrial grade. The contour of the suction cup used fits into the rectangular cavity provided to the rear end of the outer shell. The suction cup intended is of Coval vacuum suction cups (Fig 120) . The suction cup could be pulled out of the cavity and engaged on to the surface where the helmet is mounted.

The cavity where suction cup is mounted lies in between the visual elements denoting trellis frame of a KTM motorcycle. The

chin area of the outer shell houses a recess in which a portion of the visor is fit in. These areas also consist of a through hole that allows the helmet to be mounted on to the locking system which is permanently stuck to the tank / any flat surface on the motorcycle. The base of the outer shell that comes in contact with the surface it is mounted on is protected using a rubber base gasket that prevents scratches.

The visor is to be made out of polycarbonate (fig 123) and has to be flow coated to ensure better performance characteristics. Flow coating is a technique by which the visor is moved through the liquid coating. The part (visor) is not kept stationary in this process. The visor requires three different layers of coating in this case. The inner part has to be coated with an anti-fog layer whereas the outer surface of the visor requires photo-chromic coating and a layer of scratch-resistant coating. The contour of the visor as inspired from the headlamps of a KTM fits neatly into the recess created along the chin area in the outer shell. The outer shell runs beneath the chin end of the visor. A through hole is given on the visor in accordance with the hole in the outer shell. A small

Fig.121: *Rear view*

Fig.122: *Top view*

Fig.123: *Side view*

projection is given on top of this hole which helps the rider flip the visor up and also acts as a guard and doubles up as a guide for the locking mechanism to move in. The slide plates on either side of the visor are injection moulded which guard the rotational mechanism for the visor.

The redesign of inner shell borrows technologies that are currently proving to be game changers in terms of safety and innovation. It also looks at safety and comfort as its prime areas of concern. The inner shell has been redesigned in such a way that it consist of two main parts. Kranium technology which is proven to be effective for bicycle helmets, developed at RCA (Royal College of Arts) – London was piggybacked in developing the inner shell of the helmet. The framework which was used in Kranium was made out of collapsible air-filled honeycomb cells. This structure was however made out of cardboard to be used in bicycle helmets. The same cannot be however, directly used to manufacture motorcycle helmet's inner shell. Hence, a material that could replace cardboard (fig 124) at the same time which guarantees safety was looked for. A smart material renowned for impact protection and shock absorption was found to be the D3O material developed in UK (fig

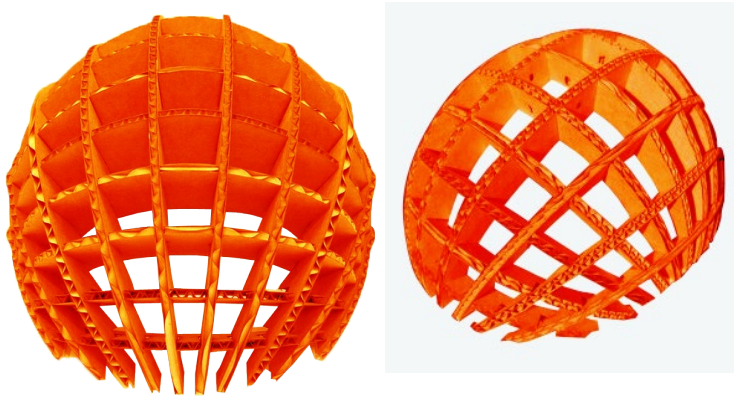


Fig.124: *D3O embedded kranium*

Fig.125: *Molded D3O*

Fig.126: *D3O material*

Fig.127: *Product visualization on KTM motorcycles*

Fig.128: *Alternative color schemes*

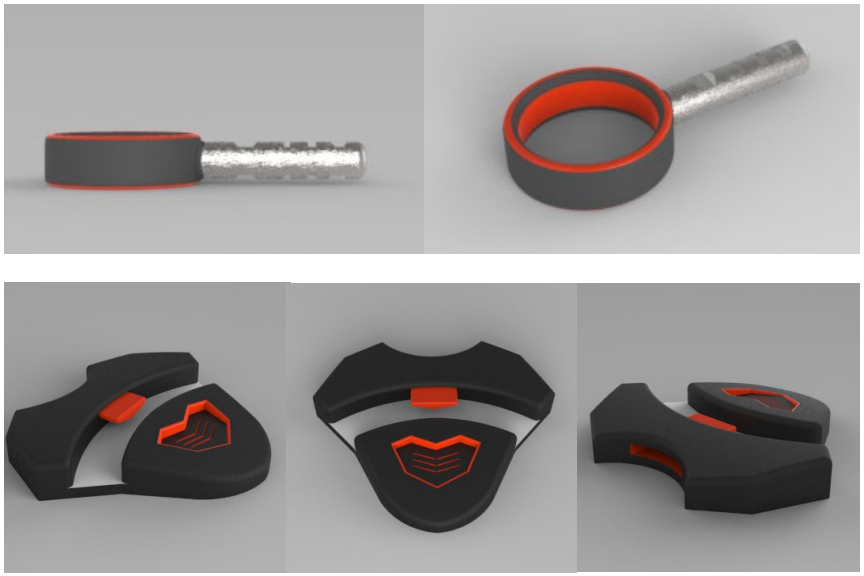


Fig.129: *Adesive lock unit*

125,126) . The stress vs strain characteristics ensure that harder the impact, greater the resistance to force. Based on the non-Newtonian principle D3O is an efficient energy absorbing plastic polymer. D3O currently produces Trust Helmet pad system that offers better protection for advanced combat helmets. Developing D3O along the same structural language as of Kranium would ensure adequate safety to be used in motorcycle helmets.

The structure as such could not be directly placed inside as the inner shell, as the impact force transferred from surface impact would be distributed locally over the skull. Hence a layer of conventional EPS (Expanded Poly Styrene) was added in between the Kranium and skull. The EPS layer acts as the force dissipater which ensures that the impact force does not locally affect get distributed over the skull. A cloth liner is then added to cap of the inner shell and add comfort to the head.

The additional adhesive unit (Fig 129) that goes along with the helmet mounts on any firm flat surface on the motorcycle. The mount houses a clip lock mechanism that houses the chin region of the helmet on it. The hole along the jawline of the helmet enables the clip lock mechanism to safely store the helmet once locked. The lock ejects a unique key which ensures the safety of helmet once its docked.

WAY FORWARD

Fig.130: *Brand name*

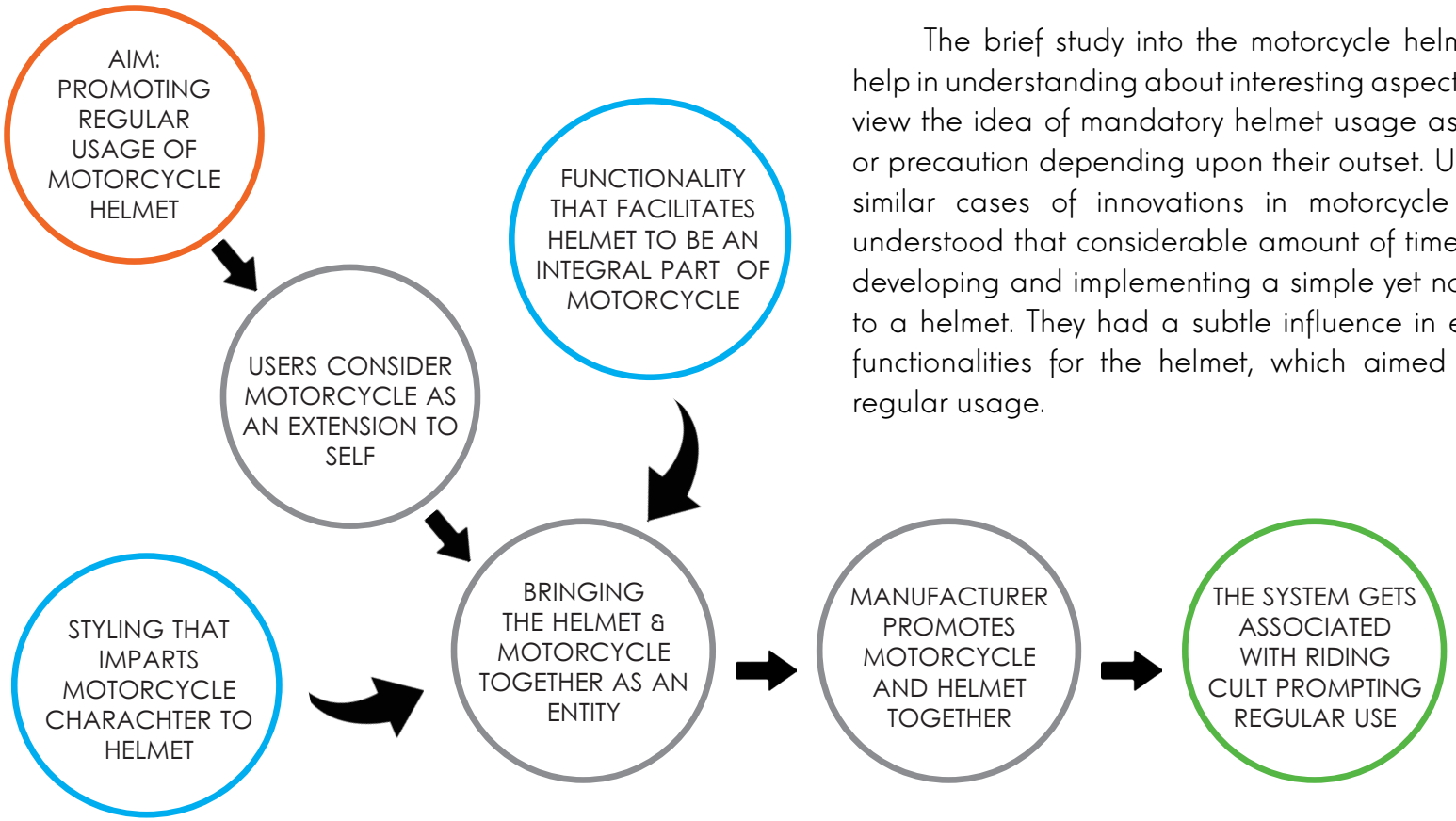
A brief study in to the favourable circumstances and market scenario for the launch of helmets were studied. As a brand ' Aeron' was selected to be the name of the product (fig 130) . In Hebrew origin it translates to ' mountain of strength' echoing the sturdy and safe character of the helmet. The product line initially includes helmets custom designed according to KTM motorcycles of Indian market. While the core benefit of the product is to protect the rider from head injuries in case of accidents, the differentiation from rest of the helmets are its locking system for storage and combination of cranium & EPS forming the inner shell. These features ensure that Aeron helmets are relatively easy for storage & use, with added advantage of being safer and lighter.

The helmets have been designed for premium motorcycles in the Indian market. The technology utilized can be used for other sectors of helmets subsequent to the response for the current model. The target users have been identified as the high income group within the age group of 20 - 30 years of age. Skimming pricing strategy (the strategy in which highest initial price that the customer

is willing to pay for the product is suggested and later on the price is reduced as the technology is utilized for more price sensitive segments) is to be employed in regard to Aeron helmets wherein the high price is interpreted as a sign of quality.

As part of promotion, the helmet will be sold through the Pro-bike showrooms (through which KTM is sold across India) showrooms. Road safety campaigns that are undertook by several rider groups could be carried out with collaboration of Aeron helmets. Promotion through exclusive bike rallies and stunt show sponsorships can also be undertaken. Social media campaigns and above the line advertising can be employed.

Conclusion



The brief study into the motorcycle helmet redesign did help in understanding about interesting aspects on how people view the idea of mandatory helmet usage as enforced safety or precaution depending upon their outset. Upon familiarising similar cases of innovations in motorcycle helmet, it was understood that considerable amount of time was invested in developing and implementing a simple yet novel idea related to a helmet. They had a subtle influence in envisioning novel functionalities for the helmet, which aimed at encouraging regular usage.

The concept of envisioning helmet and motorcycle as a single entity, where the helmet is conceived as an extension to the design language sported by the motorcycle, aims at improving the regular usage of helmet. The functional advantages and styling adopted aids in helmet being portrayed as a part of the vehicle. From the user survey it was deduced that users consider a two wheeler to be an extension of their self and aspire to be part of the cult of riders. Primarily after satisfying the user with a product he could relate to himself and his vehicle, the functional advantage also ensures that the helmet is handy every time the user embarks on a ride. The aforementioned scenario is on the rise in India and users would be open to idea wherein the protective gear associated with safe riding is in tune with the motorcycle, which would depict their character. This would in turn encourage the manufacturers to promote the selling combination of helmet and motorcycle. These qualities would improve the frequency of regular helmet usage by adding on to the culture of motorcycle riding.

The idea of motorcycle and helmet as a unit which gets completed along with the rider could form into a culture of its own, wherein users adopt the unit as an extension of themselves and to the practice of riding. This would in turn pave way for a scenario where riders would often use helmets as part of their riding culture.

References

Fig 1 < http://images2.revzilla.com/product_images/0042/4612/shoei_qwest_passage_helmet_zoom.jpg>
Fig 2 < http://www.hellenic-art.com/images/detailed/1/258000260101x.jpg >
Fig 3 <http://www.theroyalracer.com/bell-helmets/>
Fig 4 < http://images.esellerpro.com/2189/I/312/91/Ricky-Dietrich-811-Monster-Motocross-Helmet-1.jpg >
Fig 5 <http://images.leatherup.com/images/product/large/ST-1198-matte-blk-1.jpg;/images/product/large/ST-1198-matte-blk-2.jpg>
Fig 6 <http://images.esellerpro.com/2189/I/438/55/Duchinni-D506-Force-Open-Face-Motorcycle-Helmet-Force-3.JPG>
Fig 7 <http://bikesreviews.biz/wp-content/uploads/2014/10/motorcycle-half-helmet.jpg>
Fig 13 <http://www.sciencedirect.com/science/article/pii/S0924013602000468#gr1>
Fig 14-21 <http://www.araihelmet-europe.com/site/about-arai-2/production-process/>
Fig 22 <http://www.shoei-helmets.com/gt-air-common/images/gt-air-liner.png>
Fig 23-25 <http://www.dsource.in/case-study/helmet-design/slide-show/76.html#up>
Fig 26-27 <http://www.braininjury.com/injured.shtml>
Fig 28 <http://www.buzzle.com/images/diagrams/human-body/dura-mater.jpg>
Fig 29-30 <http://i24mundo.com/wp-content/uploads/2014/09/skully-ar1-designboom08.jpg>
Fig 31-32 <http://www.reevu.com/motorsports/view-the-rv-msx1/>
Fig 33-34 <http://www.jebiga.com/wp-content/uploads/2014/09/LIGHTMODE-MOTORCYCLE-HELMET-3.jpg>
Fig 35-36 <http://i.ytimg.com/vi/GZvDA7LjElc/0.jpg>
Fig 37-38 <http://www.webbikeworld.com/r2/motorcycle-helmet/lazer-superskin/>
Fig 39-40 < http://www.core77.com/blog/object_culture/invisible_bike_helmet_inflates_before_impact__17690.asp>
Fig 41-42 <http://red-dot.de/pd/online-exhibition/?lang=en&c=0&a=0&y=2013&i=0&oes=helmet>
Fig 43 <http://i.dailymail.co.uk/i/pix/2011/05/21/article-0-0C300C3C00000578-861_468x339.jpg>
Fig 44 <http://cache2.asset-cache.net/gc/116771978-casual-indian-office-workers-gettyimages.jpg?v=1&c=IWSAsset&k=2&d=q2LrjDRhumYJsvoq3DO07516jcGOHviQLD973wjnQME%3D

Fig 45 < http://cdn.bmwblog.com/wp-content/uploads/BMW-Motorrad-Ride-helmets.jpg>
Fig 46 <http://i2.wp.com/formotorbikes.com/blog/wp-content/uploads/2013/11/nexx-switx-sx-10-white-red.jpg?resize=800%2C757>
Fig 58 (II) <http://www.team-bhp.com/forum/attachments/test-drives-initial-ownership-reports/961243d1343122601-complete-pictorial-review-maruti-star-vxi-mt-edit-now-sold-042.jpg>
Fig 73 < http://royalenfield.com/newstripes/images/re_logo.png>
Fig 73 <http://vignette4.wikia.nocookie.net/rr3/images/0/05/Ktm-logo.jpg/revision/latest?cb=20140426090331>
Fig 92-97 <http://www.toolsintl.jp/?cat=9>
Fig 120 <http://www.coval-inc.com/products/cobc3065m38g-c-series-oblong-suction-pad-with-1-5-bellows-dimension-30x65-mm-3-8g-male-fitting-969.htm?mod=s>
Fig 125-126 <http://www.d3o.com/materials/>

as seen on 26 / 06 / 2015

Bibliography

http://www.sciencedirect.com/science/article/pii/S0924013602000468
http://www.motorcycle-usa.com/932/Motorcycle-Video/Schuberth-Motorcycle-Helmet-Video.aspx
http://www.pocsports.com/en/content/view/protective-concepts
http://badasshelmetstore.com/7-high-tech-helmets-2014-high-tech-high-style/
http://badasshelmetstore.com/50-coolest-motorcycle-helmets-2014/
http://fusar.com/
http://www.diseno-art.com/encyclopedia/vehicles/road/bikes/articles/advanced_helmet_design.html
http://www.toxel.com/tech/2011/02/10/12-cool-and-innovative-helmets/
http://www.pocsports.com/en/content/view/protective-concepts
http://www.caranddriver.com/features/the-physics-of-how-the-hans-device-saves-lives-feature
http://www.phillipshelmets.com/TESTING_&_CERTIFICATION1.htm
http://medind.nic.in/jal/t09/i1/jalt09i1p6.pdf
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3968579/
http://www.ijrdh.com/files/RTA%20article%206.pdf
http://data.gov.in/catalog/stateut-wise-total-number-road-accidents-persons-killedinjured-fatal-accidents-due-two#web_catalog_tabs_block_10
http://ncrb.nic.in/CD-ADSI-2012/accidental-deaths-11.pdf
http://indiatoday.intoday.in/story/india-has-highest-rates-of-motorcycle-injuries/1/151522.html
http://www.braininjury.com/injured.shtml
http://www.healthylife.com/online/HealthierAtHome/ASEA/HeadNeckSpineInjuries.html
http://www.survivetheride.org/riders/first-aid/
http://www.d3o.com/materials/
http://www.coval-inc.com/products/
http://video.nationalgeographic.com/video/i-didnt-know-that/idkt-helmet-testing
http://www.motorcycle-superstore.com/3690/mngr/motorcycle-helmet-buyers-guide.aspx

http://waset.org/publications/9997848/an-aerodynamic-design-and-analysis-of-motor-cycle-helmet-with-anti-glare-visor-
http://www.vref.se/download/18.6a462c7912efb9dc85f80004550/2008+Pinnoji.pdf
http://www.google.co.in/patents/US3425061
https://books.google.co.in/books?id=ONqEIUaBdJMC&pg=SL603-PA17&dq=motorcyclists+and+helmets&hl=en&sa=X&ei=otjDVI2gB8LZmAXO1oLgCw&ved=0CBwQ6AEwAA#v=onepage&q=motorcyclists%20and%20helmets&f=false
http://medind.nic.in/jal/t09/i1/jalt09i1p6.pdf
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3968579/
http://www.ijrdh.com/files/RTA%20article%206.pdf
http://data.gov.in/catalog/stateut-wise-total-number-road-accidents-persons-killedinjured-fatal-accidents-due-two#web_catalog_tabs_block_10
http://ncrb.nic.in/CD-ADSI-2012/accidental-deaths-11.pdf
http://indiatoday.intoday.in/story/india-has-highest-rates-of-motorcycle-injuries/1/151522.html
http://www.quora.com/Why-are-most-people-vehemently-against-wearing-helmets-while-riding-motorcycles-in-Indi
http://www.araihelmet-europe.com/site/about-arai-2/production-process/
http://www.araihelmet-europe.com/site/home/real-world-protection/helmet-technology/
http://www.sciencedirect.com/science/article/pii/S0924013602000468
http://www.motorcycle-usa.com/932/Motorcycle-Video/Schuberth-Motorcycle-Helmet-Video.aspx
http://video.nationalgeographic.com/video/i-didnt-know-that/idkt-helmet-testing
https://www.youtube.com/watch?v=Me92ffAzoFE
http://www.pocsports.com/en/content/view/protective-concepts
http://badasshelmetstore.com/7-high-tech-helmets-2014-high-tech-high-style/
http://badasshelmetstore.com/50-coolest-motorcycle-helmets-2014/
http://fusar.com/
http://www.diseno-art.com/encyclopedia/vehicles/road/bikes/articles/advanced_helmet_design.html
http://www.toxel.com/tech/2011/02/10/12-cool-and-innovative-helmets/

as seen on 26 / 06 / 2015