Project work title: Foldable Motorcycle helmet
Group 3-37
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Problem Finding:
A mind map of was drawn to detail some safety considerations

As seen in the mindmap (Figure 1), several modes of transport were detailed.
Safety concerns for those modes of transport were taken down.
Some concerns included: falling down when learning to ride a bike, **sustaining a head injury after a motorcycle accident**, entering the blind spot of a large vehicle and pedestrians crossing the road when the traffic light had already turned red.

A problem was selected based on some considerations.

<u>The first **(and most important)** consideration was: How serious is this problem?</u>
This was ranked as the most important consideration as a problem may not be worth solving if it is insignificant. If it is rare and minor, an invention to solve the problem might be nugatory.

<u>The second consideration was: Is this an issue that could be easily solved by a change in behaviour rather than an invention?</u>
This consideration is important as there would be no need to invent something to solve the problem if the problem could be solved by a change in behaviour.

<u>The third consideration was: Is experience needed with this problem?</u>
This is another important consideration as having experience with the problem yields one a clearer view of the problem.

Experience was weighted as the lowest. This is because research can be done to find out about problems and personal experience is not absolutely necessary.

Here is the decision-making matrix:

Considerations (weightage at the side)	Weightage	People Falling down when learning how to cycle	Motorcyclists getting head injuries during a crash	Pedestrians entering a blind spot of a vehicle (therefore might get injured)	Pedestrians crossing the road after 5s warning
Was the problem one that needs an invention (or can it just be a change in behaviour)?	2	2	3	3	1
How big/serious is this problem?	3	1	4	3	3
Is it something we have experience with?	1	4	1	1	2
Total:		11	19	16	13

Using the decision-making matrix, the problem chosen was **'Motorcyclists getting head injuries during a crash'** as it was the most pertinent issue.

Extent of problem:

Why do motorcyclists get head injuries during a crash?
A study (Faryabi *et al*., 2014) found that the leading cause of head injuries sustained from motorcycle accidents was not wearing a helmet at the time of the accident. 50% of riders who died in accidents were not wearing helmets and an estimated 37% of those people could have survived if they wore helmets. Helmets by themselves reduce risk of non-fatal head injuries by up to 69% (Hinchliffe, 2019). As such, wearing helmets could be the difference between life and death.

This begs the question: Why don't motorcyclists wear helmets?

A survey **conducted on Motorcyclists** admitted to the Emergency Ward of Shahid Bahonar Hospital in Kerman showed that motorcyclists do not wear helmets due to many reasons. Such reasons include:

- heavy weight of the helmet (77%)
- pain in the neck (69.4%)
- feeling of heat (71.4%)
- difficulty of preserving or holding the helmet before and after the ride (59.2%)
- feeling of suffocation (67.7%)

Although the results showed that there are many reasons for people not wearing helmets, a certain result caught our attention. This reason was: **"difficulty of preserving or holding the helmet before and after the ride"**; a reason cited by 59.2% of the motorcyclists. Not wearing a helmet because of feelings of heat or suffocation were highly significant as well.

A task was therefore set to find a solution to these problems with the hopes of coming up with a helmet that more motorcyclists would use.

Here are some products currently available in the market:
One such product is the *Proteus helmet* (Fig 2A). It is a full face helmet and was designed by a student designer Jessica Dunn. Her main idea was to create a helmet that could fit in a backpack. When folded, the helmet undergoes a 20% volume reduction. The Proteus Helmet looks to alleviate the general inconvenience of hauling a helmet around by making it foldable when not in use. Various parts of the helmet push up the upper shell, creating a 20% volume reduction. However, some users have remarked that a 20% volume reduction is not enough.

Another such product is the *Trilo helmet* (Fig 2B). This helmet undergoes a 45% volume reduction when folded, significantly more than the Proteus helmet. However, an open-faced helmet provides less protection for the rider in the event of a crash.

This was the proposed invention:

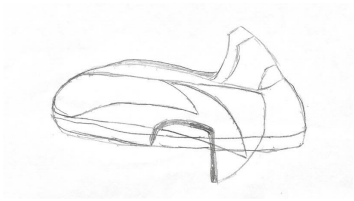


Figure 3A: Helmet when **opened**

Figure 3B: Helmet when **closed**

The proposed motorcycle helmet is **ribbed** and folds into a **single piece**. The pieces overlap each other, thus allowing the helmet to effectively fold into one piece.

Here is the helmet's locking mechanism (Button lock):

Figure 4A:
Typical button lock

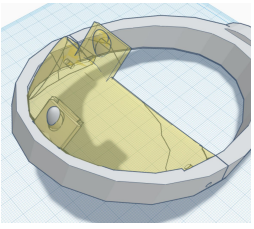
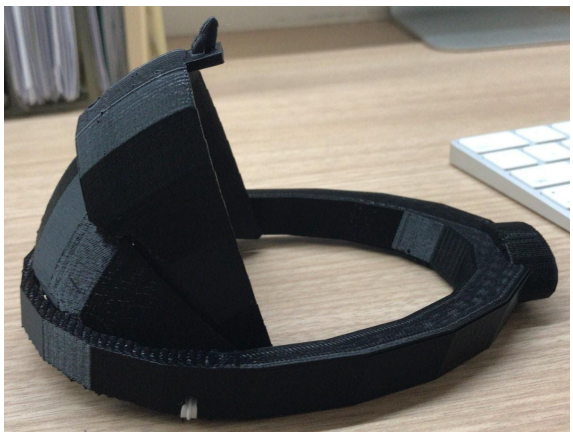


Figure 4B:
3D rendering of
button lock in helmet

How the helmet folds:
Please refer to figures 3A-3E

Here is a model of the helmet (3D printed):



**the last fold of the helmet is missing due to printing errors*

The helmet's shell would be made of polycarbonate plastic, similar to that of a majority of commercial-available motorcycle helmets.

Safety feature of the helmet: The helmet is also lined with a thin layer of Expanded PolyStyrene. PolyStyrene is a crushable foam commonly used in helmets nowadays. It is cheap to manufacture, reducing cost price for users; light, enhancing portability. It also recoils very little, thus making it highly effective at reducing the force applied to the user's head in a collision.

The helmet also has a suspension headband located below the foam (currently used in military helmets). This suspension band prevents the user's head from being in direct contact with the motorcycle helmet during an accident, minimising the impact on the motorcyclist's head during an accident.

Last but not least, the helmet's folds are also corrugated, thus spreading the impact evenly around the helmet.

How significant is the motorcycle helmet's volume reduction?
The calculation of the helmet's volume reduction was done using the following steps:
First,
The volume of the helmet was calculated by calculating the helmet as an oval. (formula:
Volume = 4/3 × π × radius 1× radius 2 × radius 3
The volume of the helmet was calculated by calculating the helmet when folded as an oval. Afterwards, the volume reduction was calculated by:
(Volume of helmet when folded - Volume of helmet) ÷ Volume of helmet x 100%

Volume of helmet when not folded is

4 ÷ 3 x π x 12.1cm x 9.4cm x 8.3cm =

3954.39388251cm3

Volume of helmet when folded is

4 ÷ 3 x π x 2.4cm x 14.2cm x 8.9cm =

1270.51033459cm3

The total reduction of volume of the helmet

2684cm3 ÷ 3954cm3 x 100% = 68% (to nearest percent)

What are the benefits of the foldable motorcycle helmet over commercially-available products?

Firstly, the proposed helmet is a full-face helmet. According to the US National Highway Traffic Safety Administration, a rider is 38% more likely to injure his or her chin when wearing an open-helmet (such as the Trilo helmet) as compared to a full-face one.

Secondly, it has ventilation slits which helps to cool down the rider. The slits are formed by the openings and they allow air to pass through easily. This makes wearing the helmet less hot, something that is significant as the study cited in the introduction showed that 71.4% of motorcyclists opted not to wear helmets as they felt that it was too hot. Few other motorcycle helmets have such ventilation slits.

Thirdly, it has additional safety features, as mentioned above.
Lastly, and most importantly, the helmet undergoes a 68% volume reduction when folded! This is significantly more than that of the Protus or Trilo helmets.

Conclusion

As such, the proposed product is more comfortable and portable than regular motorcycle helmets with a volume reduction of 68%. Furthermore, the helmet provides more ventilation and is more comfortable. All of these have not come at the expense of the motorcyclist's safety.

References/Citations

Faryabi, J., Rajabi, M., & Alirezaee, S. (2014, September 23). Evaluation of the use and reasons for not using a helmet by motorcyclists admitted to the emergency ward of shahid bahonar hospital in kerman. Retrieved August 08, 2020, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4276706/

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Jain, U. (2016, April 06). TriLo- Foldable open-face motorcycle helmet. Retrieved August 08, 2020, from https://www.behance.net/gallery/34564787/TriLo-Foldable-open-face-motorcycle-helmet

Hinchliffe, M. (2019, September 30). Crash statistics on motorcycle helmets. Retrieved August 17, 2020, from https://motorbikewriter.com/crash-statistics-motorcycle-helmets/

World Health Organisation. (2006) Helmets: A road safety manual for decision-makers and practitioners. (n.d.). Retrieved August 17, 2020, from https://www.who.int/publications/i/item/helmets-a-road-safety-manual-for-decision-makers-and-practitioners

Appendix

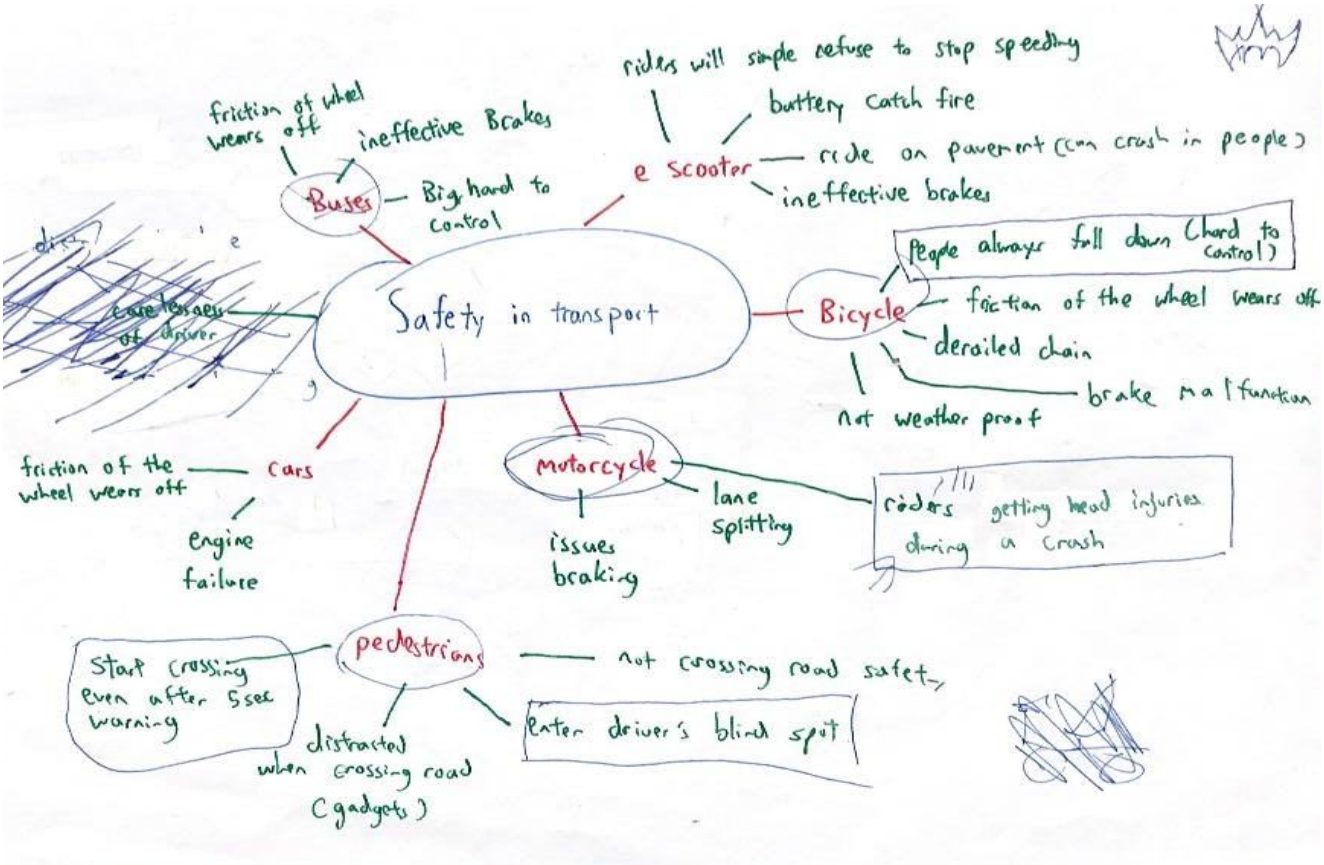
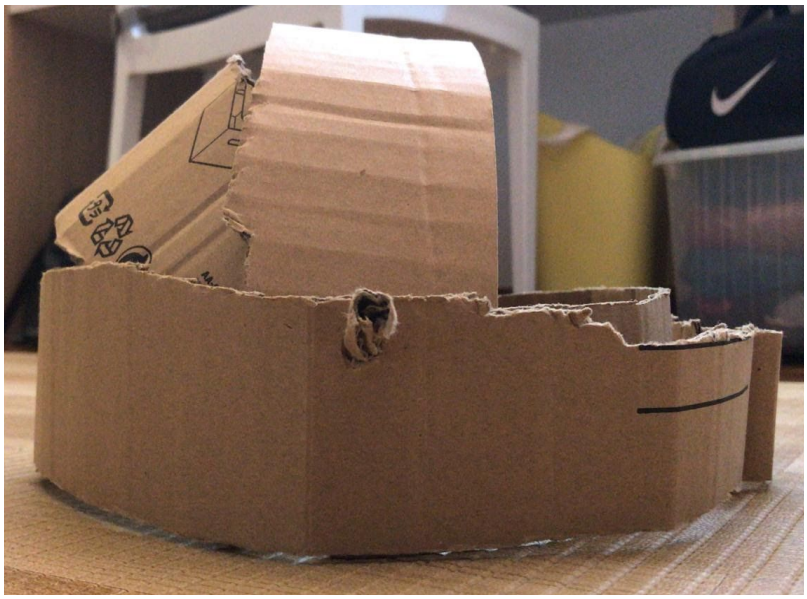


Figure 1: Mindmap used in ideation process

Figure 2A: Protus helmet

Figure 2B: Trilo helmet



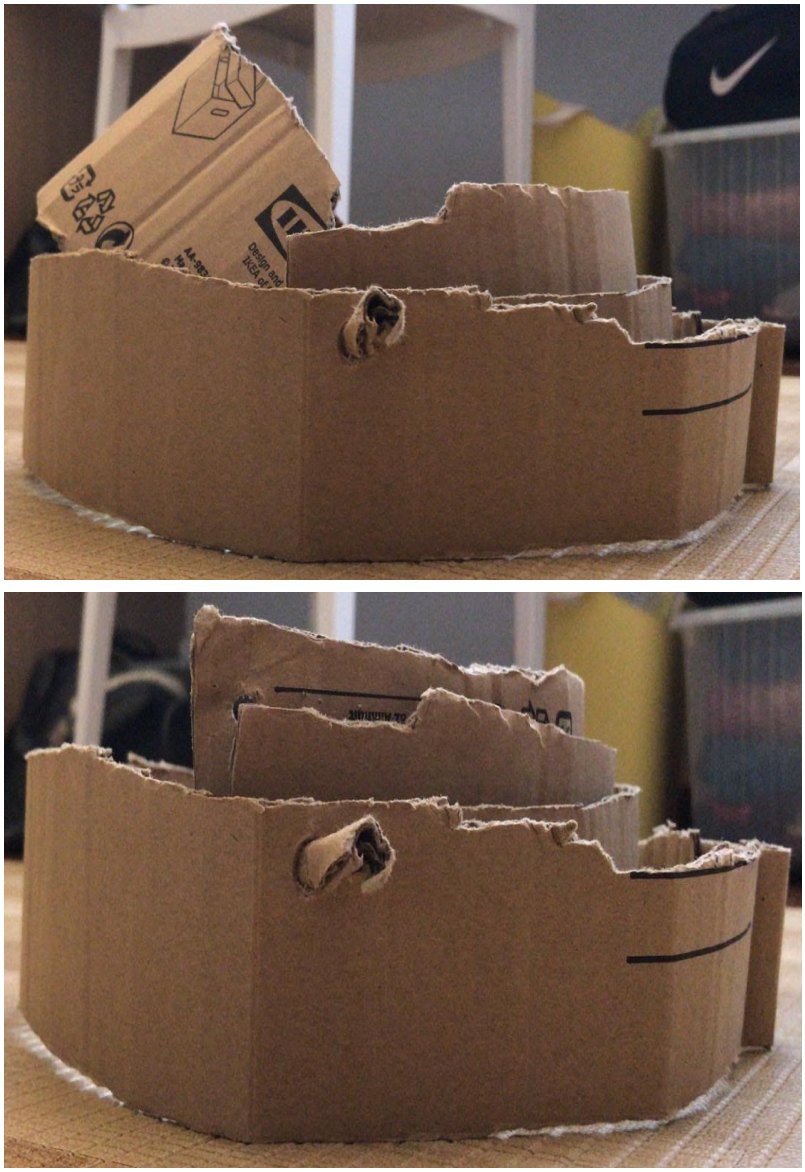


Figure 3A-E

Thank you