Design Thinking Lab (18ME47)

MATERIAL SELECTION AND FRAME DESIGN OF E-BICYCLES

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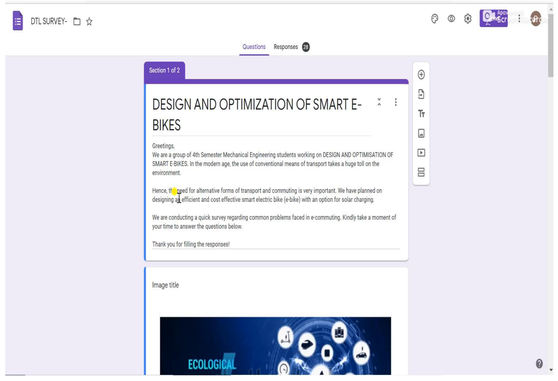
OBJECTIVE

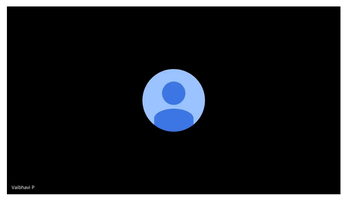
Our project deals with material selection and frame design of e-bicycles with the aim of improving design on the basis of consumer feedback.

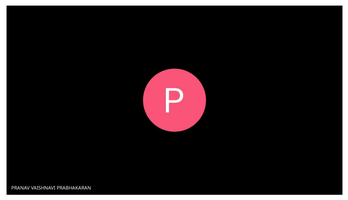
Project Methodology

E-bikes are bicycles with an integrated electric motor used to assist propulsion. E-bicycles provide a cleaner alternative to conventional transportation. We have conducted several interviews and meetings with users of electric bicycles developers and other target groups to determine areas of focus required for the design of components of the bicycle. The most prominent/ main target consumers/demographic for our project is the working age population (ages ranging from 15 years- 55 years). The target consumers hence include students and professionals, who would benefit from this means of commuting. The interviews/questionnaires have been conducted based on the aforementioned age group.

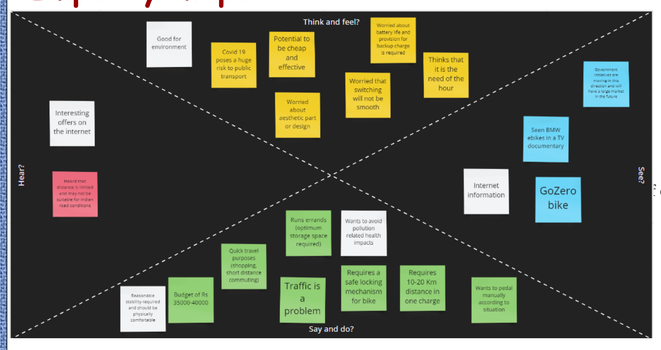
EMPATHISE PHASE: Interviews and questionnaires

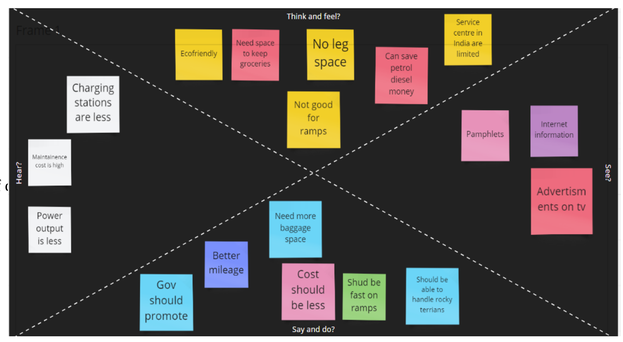






Empathy maps





DEFINE PHASE

AREAS OF FOCUS

- Charging station efficiency/availability improvement
- Design aesthetic improvement (for longer distance, baggage)
- Improvement in battery management system
- Improvement in material and frame design
- Implementation of auxiliary charging system (such as using solar panel/photovoltaic cells)
- Improvement in gear design and selection
- Improvement in wheel design and selection

PROBLEM STATEMENT

Material selection and frame design of e-bicycles with the aim of improving design on the basis of consumer feedback.

Introduction to frame materials

IDEATION PHASE

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POSSIBLE MATERIALS FOR E-BICYCLES

	Modulus of Elasticity, E (GPa)	Ultimate Tensile Strength (MPa)	0.2% proof stress at Yield (MPa)	Elongation at Failure (%)	Fatigue Limit/ UTS (5x10 cycles)	Density (Mg/m - specific energy
Steels						
Medium Carbon	200	520	310	26	0.5	7.85
CrMo (AISI 4130)	200	1425	1240	12	0.5	7.85
Aluminum Alloys						
2024-T4	73.1	470	325	20	0.29	2.8
6061-T6	68.9	310	276	12	0.31	2.8
7075-T6	71.7	570	503	11	0.265	2.8
Magnesium	44	248	200	5 to 8	0.37	1.79
Titanium Alloys						
IMI 125	105 to 120	300 to 540	340	20 to 29	0.5	4.51
IMI 318	105 to 120	1000	900	8	0.55	4.42
Composites						
"S" glass-epoxy	90	3750	3450	3.5	0.16	2.63
HT graphite-epoxy	221	3600	2000	1.25	0.25	1.75
Boron-epoxy	250	1200	?	?	0.8	1.9
Boron-Aluminum	165	1025	?	0.65	0.7	2.4
Kevlar-49-resin	75	1380	?	2.75	0.7	1.45
Glass-nylon	2.3	59.9	59.9	14	?	1.18
Woods	12	100	60	?	?	0.67

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Introduction to frame geometry

E-BICYCLE FRAMES

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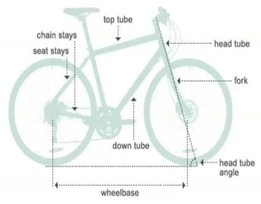
- The frame is the most important component in the electric bicycle. Its innovative geometry is different from the actual bicycl frames because the battery is located inside it, just between the seat and the fork tube, thus avoiding the need for extra support to accommodate the battery.
- A frame determines what combination of parts an electric bicycle can accept, what kind of use it is best for and what kind of seating positions can be achieved



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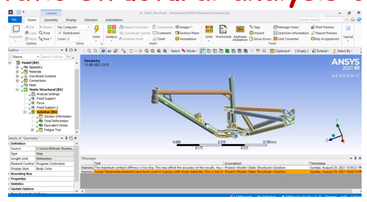
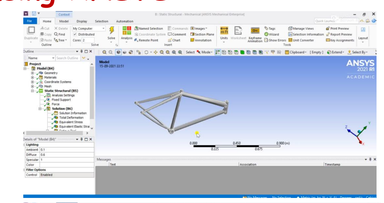
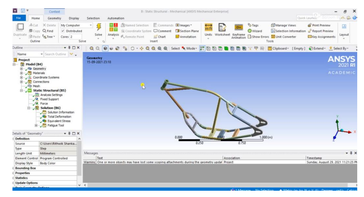
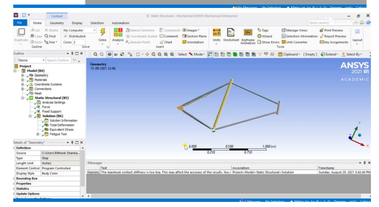
Frame designs considered

Static structural analysis of frames using ANSYS

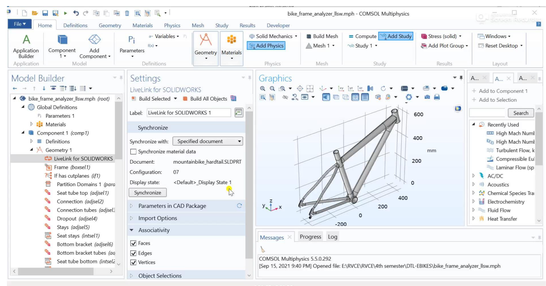


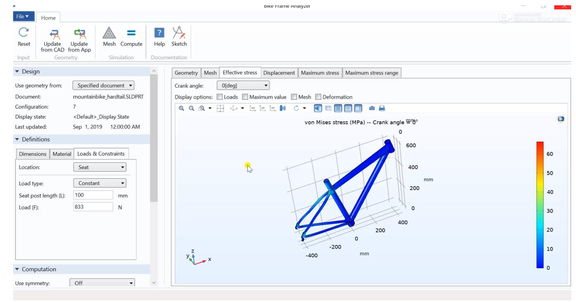


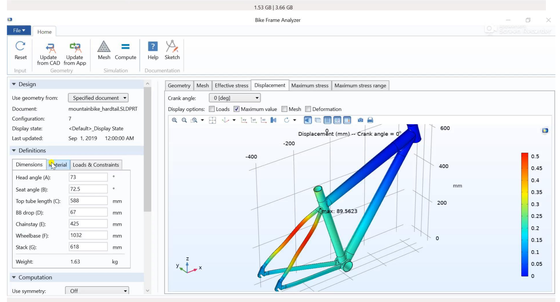


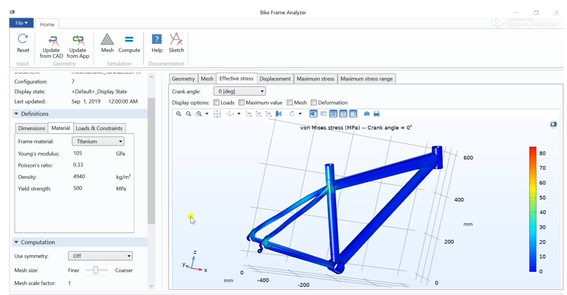


Analysis of final frame model









Conclusions

- Hardtail type model has been selected as the e-bicycle frame.
- Material selected :AISI 4130
- It is a low alloy-steel containing Chromium and Molybdenum as strengthening agents.
- It has a good strength and toughness, corrosion resistance, weldability, machinability and moderate cost.

Outcomes and design improvements planned

- A comfortable seat is a very important factor in the overall the comfort of your bicycle and its ride quality. Because there is less pedaling than normal bikes, consider switching over to a seat designed for a cruiser bike.
- These are larger and more comfortable than standard bicycle seats.
- Slots/auxiliary structures can be added to house the battery casing and pedal-assist components.

Acknowledgements

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