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Ultralight Personal Four-Wheel EV

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Executive Summary

Especially in urban and slow traffic areas, small electric vehicles are needed, not only to avoid pollution, but also because of limited parking and road space. What we need is a new vehicle class, defined by the following criteria: – as compact as possible, – as light as possible, - not faster than necessary.
Low speed is the most effective means to reduce vehicle weight and increase efficiency. Lightweight design is not only a question of material, but also a question of how to combine the best structural properties and how to join different materials. It is not sufficient just to replace steel by aluminum or carbon fiber. Therefore, creative ideas are needed, not only for lightweight structures, but also for new power trains and steering concepts. Therefore, University of Esslingen initiated a competition for ultra-light vehicles (ULVs).

Keywords: education, bicycle, light vehicles, mobility concepts, renewable

1 Introduction

The benchmark for the new vehicle class is the so called “MaYi”, developed by Prof. Janach from Luzern University of Applied Sciences in Switzerland [1]. Its load carrying structure is a 100 mm thick sandwich platform with polystyrene foam core, 0.5 mm aluminum sheet on the top, 0.25 mm on the bottom and 1 mm on the two sides. This results in to a very stiff and extremely light design. With a weight of only 3 kg the platform can carry two people (Fig.1). Wheels, brakes and motor come from bicycle industry (Fig. 2).

Fig. 1 ULV with sandwich platform

Fig. 2 Platform with integrated E-bike motor and chain to differential

Design characteristics of the "MaYi" bench mark prototype:

- as simple as possible,
- 100 mm thick sandwich platform,
- 1.2 m long, 0.85 m wide, 24 kg with battery,
- steering with a mechanical joystick,
- foot brake with a rolling ribbon,
- 250 W E-bike motor for a speed of 20 km/h.

2. Design-Studies

New design concepts were created by student projects. The most important criterion was the use of sustainable materials such as wood, paper and natural fibers. While maintaining the drive train and steering system of MaYi, an advanced design proposal is shown in Fig. 3, inspired by a special chair design.

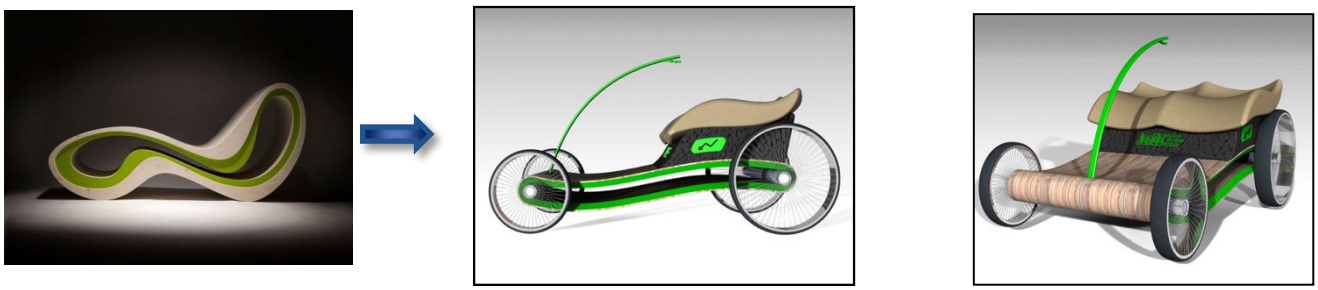


Fig. 3: ULV-Design-Study

A further development with a frame structure made of bamboo tubes and mats of natural fibers can be seen in Fig. 4.

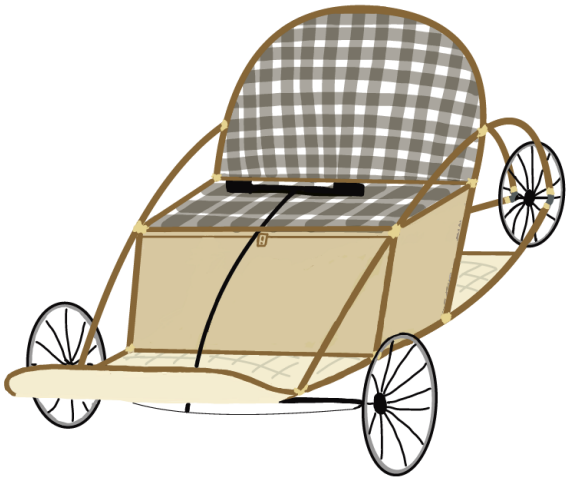
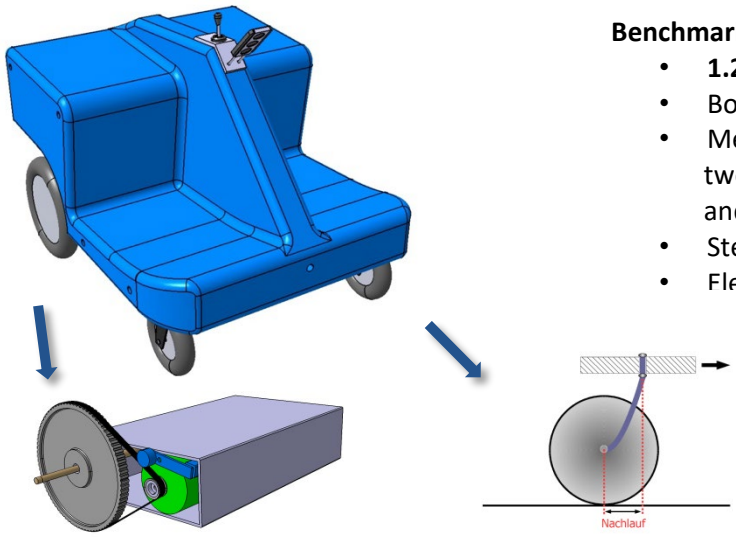


Fig. 4: Design-Study for ULV based on renewable materials (Bamboo, HEMP-fibres)

3. Advanced ULV concept

Analyzing MaYi leads to the questions, how to simplify the elaborate and expensive platform, also how to reduce mechanical drive and steering components. How to create a vehicle concept with the prospect and the ability to become a lifestyle product? The solution by the Institute for Sustainable Energy Technology and Mobility (INEM) is shown in Fig. 5. The most important change is eliminating the aluminum sheets with the labor-intensive rivets and replacing the drive train and steering by two independent wheel hub motors in the rear, controlled by an electronic joystick. The front wheels are trolley wheels, well known from the shopping trolley. Spot turn (like dancing boogie) is possible, which is important when driving in slow traffic areas and public buildings.



Benchmark prototype "Boogie"

- **1.2 m** long, **0.85 m** wide, **22 kg** with battery,
- Body made of Styrodur,
- Mechanical steering and gear replaced by two independent wheel hub motors in the rear and two "trolley-wheels" in the front
- Steering by a **joystick,**
- Electric **brake**

Fig. 5: New ULV-concept „Boogie"

The entire body is made from impact-resistant hard foam, used also for thermal isolation. The structure is self-supporting. The armrest in the middle provides enough space for the electronic components and increases stability. The battery is located under the seats.

The flat and rectangular body shape does not only facilitate the manufacturing, but also leads to compact piling up in parking areas.

4. Further Studies

Based on the design shown in Fig. 5, a new vehicle concept was born from the idea of using two shells, a subshell made of plastic injection moulding and a topside made of plexiglass, see Fig. 6.

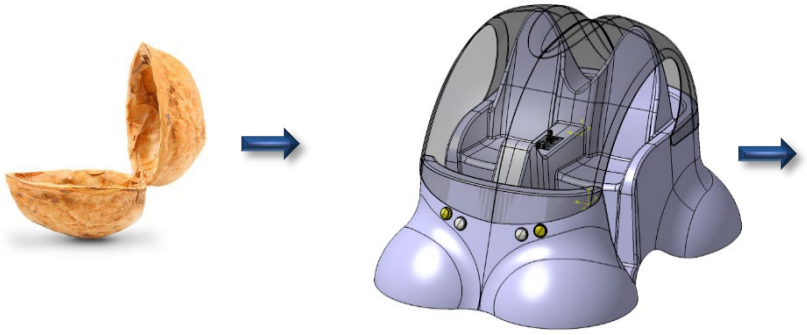


Fig. 6: Nutshell concept study

Fig. 7: Vision for Urban City ULV based on the Nutshell concept study

A vision for an Urban City Lightweight Vehicle is shown in Fig. 7 in front of the campus of the university of Esslingen.

5 Conclusions

Development must continue in order to get the ULV design ready for the market. Therefore, INEM is looking for support for optimizing materials, drivability, design and production methods. Finally, the ULV subject is important for educating students in the holistic approach to a System as a whole. They need to connect their acquired knowledge in mechanics, electronics, design and other skills. Because of the simplicity of ULV, they are able to keep the overview of these different subjects.

References

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Presenter Biography

Prof. Dr. Hugo Gabele studied aerospace engineering at the University of Stuttgart, worked for MAHLE for 10 years and received his doctorate on the subject of engine acoustics. He teaches design and light weight vehicles at Esslingen University of Applied Sciences. He has been working together with Prof. Walter Janach for 10 years.