

Poster Presentation for the EVS30 Symposium in Stuttgart,  
Germany, October 9 - 11, 2017

Prof. Dr.-Ing. Hugo Gabele,  
Institute for sustainable energy technology and mobility  
University of Esslingen, Kanalstr. 33, D-73728 Esslingen

Prof. (emer.) Dr.-Ing. Walter Janach,  
Luzern University of Applied Sciences, Switzerland

M.Eng. Martin Ziegler, Manager of Hyliontec and  
Lecturer at the University of Esslingen

## Ultra-Light Vehicle (ULV) as a Lifestyle Product

### 1. Introduction

Personal transport will become different and more complex. A colorful mixture of hybrid and electric cars are already on the market. Especially in urban and slow traffic areas, small electric vehicles are already in demand, not only to avoid pollution, but also because of limited parking 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), which took place for the first time on June 18<sup>th</sup>, 2016 and for the second time on June 3<sup>rd</sup>, 2017.

### 2. ULV- Prototype „MaYi“

The bench mark 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 styrofoam core, 0.5 mm aluminum sheet on the top, 0.25 mm on the bottom and 1 mm on the two sides. This leads to a very stiff and extremely light design. With a weight of only 3 kg the platform can carry two persons (Fig.1). Wheels, brakes and motor are derived from bike industry (Fig. 2).



Fig. 1 Prof. Walter Janach and Prof. Ferdinand Panik on test drive. Normal use with one person in center.

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 Ebike motor for a speed of 20 km/h.



Fig. 2 Platform with integrated Ebike motor and chain to differential

### 3. Design-Studies at the University of Esslingen

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

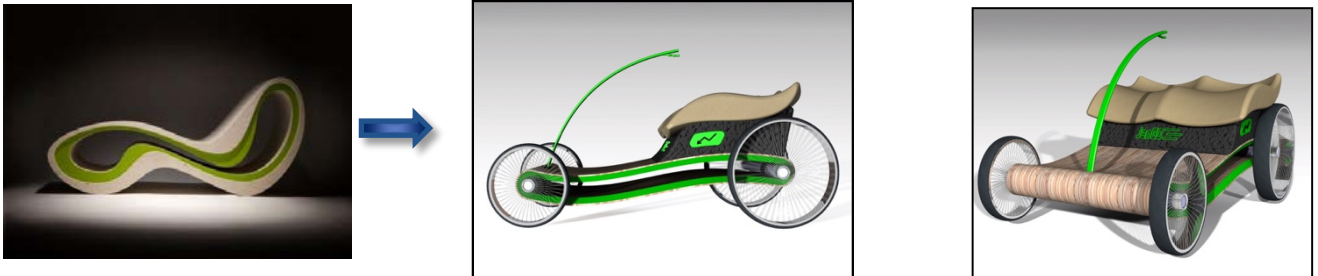
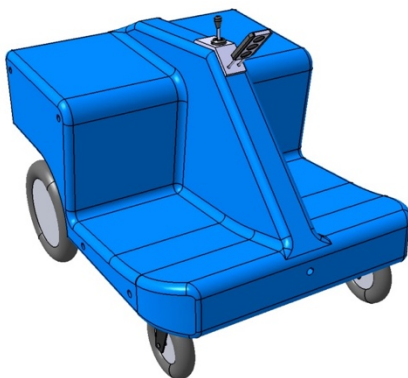


Fig. 3: ULV-Design-Study

### 4. Advanced ULV concept

Analyzing MaYi lead to the questions, how to simplify the elaborate and expansive platform, as well as how to reduce mechanical drive and steering components. How to create a concept with the prospect and the ability to become a lifestyle product? The answer of the Institute for Sustainable Energy Technology and Mobility (INEM) is shown in Figure 4. The most important step towards this solution is the elimination of the aluminum sheets with the labour-intensive rivets and the replacement of the mechanical drive 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 2 independent wheel hub motors in the rear and 2 “trolley-wheels” in the front
- Steering by a **joystick**,
- Electric **brake**

Fig. 4: New ULV-concept „Boogie“

The body is made from impact-resistant hard foam only, used also for building isolations. The construction is self-sustained. The armrest in the middle provides enough space for the electronic components and increases stability. The battery is located under the seats.

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

## 5. Creative Experimental Cars (CRECS)

Maintaining the driving concept of the Boogie, different designs of the body are possible. It is a minimalist approach and there are no limits. As an example, the winner of the first ULV competition [3] was the prototype “Transporter”, shown in figure 5. The idea is as simple as crazy: A dustbin, made from cheap plastic, manufactured by injection moulding, is used as a chassis. The driving components are screwed on and the control unit with a joystick is implemented.

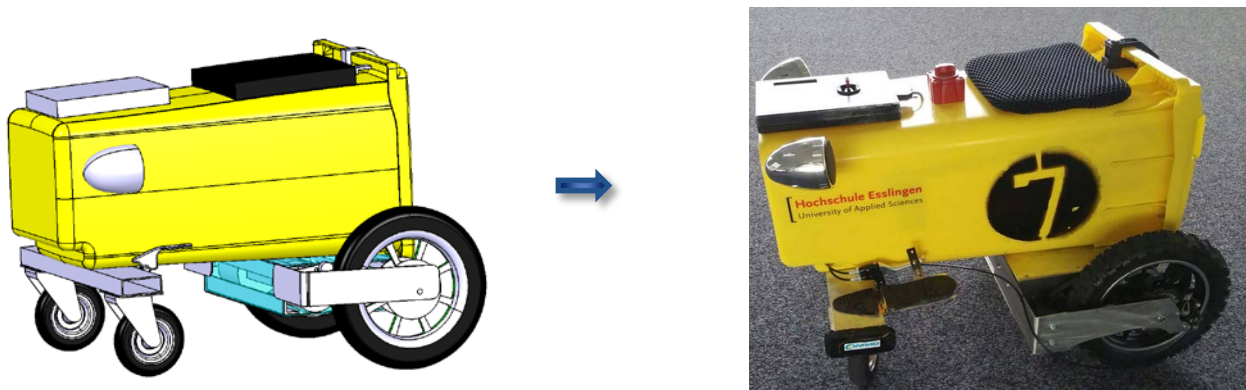


Fig. 5: Prototype “Transporter”, using a dustbin as a chassis, cargo volume 120 l, steering and driving like “Boogie”, see above

Powered by two 1,4 kW motors, the transporter has a very good performance and especially a sharp acceleration. Because of wheel shimmy at higher speeds the velocity is currently limited to 20 km/h.

## 6. Conclusion

Development must continue in order to get the ULV ready for the market. Therefore INEM is looking for support in optimizing drivability, design and production methods. Overall, the ULV subject is eminently suitable for the education of students, because they have to look at the 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 these different subjects under control.

## References:

- [1] Walter Janach, Zhuo-ming Huang, Hang Yin and Xiao-jun Tan. *UCV- An Ultra-light Personal EV to Solve the Urban Traffic Problems (in Chinese)*. In Proceedings of the 7th National Conference on Light Electric Vehicles. Shanghai: 2009.
  
- [2] <https://www.hs-esslingen.de/de/hochschule/service/inem-institut-fuer-nachhaltige-energietechnik-und-mobilitaet/indie500.html>
  
- [3] Stuttgarter Zeitung: „Von der Mülltonne zum Transporter“ Ausgabe vom 20.06.2016