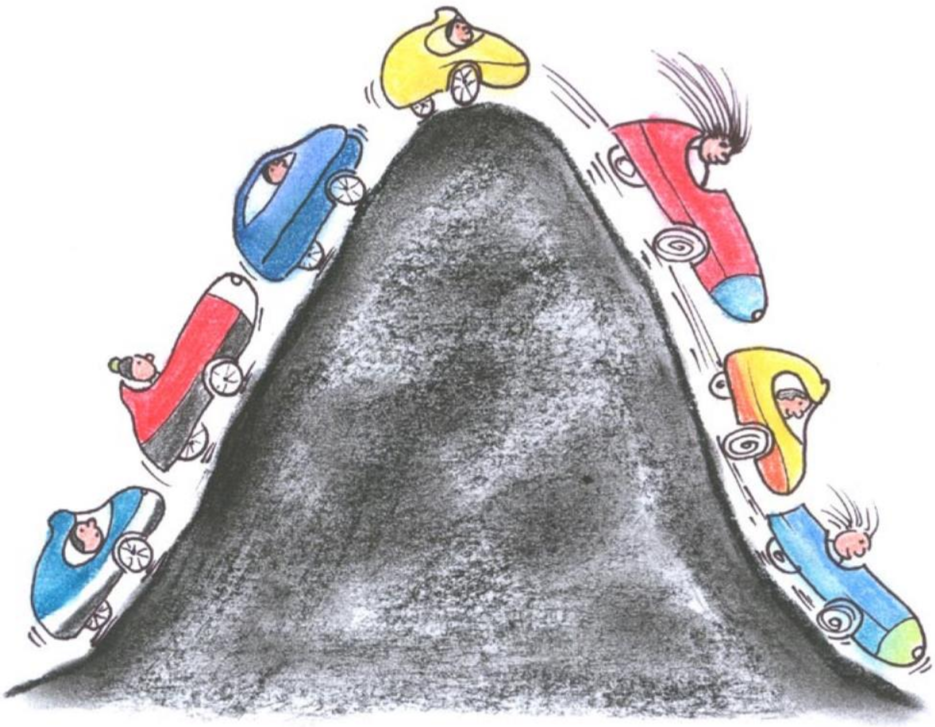
6th European Seminar on Velomobile Design

Copenhagen, October 16th - 17th 2009



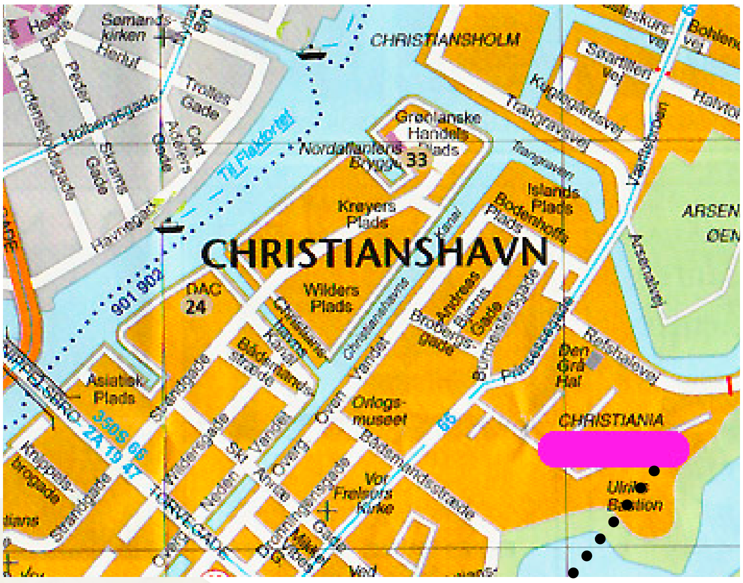
The series of Velomobile Design Seminars started in 1993 in Copenhagen. Through 15 years the seminars have been an important inspiration to the development of velomobiles for practical transport and sport.

The perspectives for velomobiles as an alternative, environmentally friendly means of transportation are today more obvious than ever. In many situations a velomobile can replace a car, offering cargo space, weather protection, better aerodynamics and higher speed than an ordinary bicycle. People need more physical exercise for health care reasons, to stay or to become fit, to improve quality of life. A velomobile is a comfortable and secure means to get training.

The velomobile doesn't increase greenhouse-gas emissions, an issue which has gained increasing attention in the last 5 years. The United Nations (Conference of Parties under UNFCCC) has called for the next Climate Conference in the first week of December 2009. It will take place in the Bella Center in Copenhagen. On this occasion, we will demonstrate the potential of velomobiles for an environmentally friendly lifestyle.

Registration, fee and accomodation

No prior registration is necessary. The seminar participants registre at the entrance to the conference room and pay a small fee of 20 Euro.
Accomodation can be found in Copenhagen and suburbs at very moderate prices (15–30 Euro).
There are special low prices for groups in Hostels.
Please check www.visitcopenhagen.com.
It is recommended to make an early reservation.



Velomobil Design Seminar

Afholdes af Leitra og Liggecykelforeningen

Det sjette velomobil design seminar afholdes fredag 16. oktober fra 10-16 i "Fabrikken" på Christiania. Entré koster 150 kr (eller 20 €). Nedenfor en sammenfatning af alle indlæggene på seminaret. Omtalerne er de originale (typisk på engelsk), da det er de sprog indlæggene også bliver holdt på.
Om lørdagen (17/10) køres en paradetur gennem København med afsluttende pressemøde. Turen starter kl 11 på Rådhuspladsen og slutter ved 14-tiden på Israels Plads.

Ingo Kollibay, Tyskland — Four-Wheeled Velomobiles
Today there is a certain standard in velomobiles: They are three wheeled, aerodynamically shaped like a drop and mostly have a fairing which is self-supporting. This makes them fast and simple.
The typical disadvantages of this type are limited luggage space, limited braking ability, poor stability against overturning in curves, poor traction in winter conditions and there is always the question where to store it safely.
The concept of the four-wheeled velomobile allows for optimizing every one of these disadvantages with the exception that it is not optimized considering aerodynamics and top speed. Its wider range of abilities makes it more practical for everyday's mobility needs. So there is the chance to reach a much wider range of users, compared to the typical velomobile owner of today.

Antal Joó / Gabor Joó, Ungarn — Possibility and Situation of Velomobile Riding in Hungary
In this presentation, you will find several critical remarks on the situation in Hungary. I would like to underline that the criticism is for the sake of cycling and not against something or some people. I am optimistic that cycling and velomobile riding will some day be so considerable in the transportation of Hungary as is now the case in Denmark, Netherlands or Germany. The changes in the world will force us to do so if our discretion and wisdom should prove to be insufficient.

Jürgen Eick, Tyskland — Twenty Years of Experience with the Velomobile Leitra
1. In 1988 I ordered my first Velomobile. Have my expectations been fulfilled?
2. Questions arising from people who have not yet had any experience with a Velomobile and my answers.
3. Is the Velomobile simply fun for sports and leisure activities or is it a mean of transportation?

Simon Bailey, England — CabrioVelo™ and WeatherVelo™ – velomobiles for practical daily use
This paper describes two "sister" velomobiles, which have been designed around a common concept: practical personal transport for short to medium length journeys. The CabrioVelo is an electrically assisted velomobile with folding roof, developed over many years by Christian Wagner (www.4sev.de) and styled by Jürgen Mayerle (www.schoene-linie.de). The WeatherVelo is based on the CabrioVelo, but specified by the author for the London market, featuring a rigid roof. This velomobile offers a solution to the pollution and traffic congestion caused by cars in towns and cities. The health benefits of cycling are retained; but with the advantages of greater road presence, weather protection, inherent stability and an integrated luggage box. Various opportunities and challenges of velomobile use in London are also illustrated.

Suhas Malghan, USA — Design and Development of the Turanga Velomobile
Velomobiles have not entered the mainstream of transportation in the US despite the fact that a velomobile would have great utility to a growing segment of society. This paper describes the design and prototype build process thus far to bring a velomobile designed for the American market and consumer. Its design features include a bamboo/balsa laminate structure surrounded by a lightweight fabric and Coroplast body as well as tilting capability, full suspension, nearly stepless gearing and front wheel drive. The prototype is mid-way through the build process as the chassis has been constructed with the body yet to come. Design, manufacturing and marketing issues pertinent to the US market are also discussed.

Andreas Fuchs, Tyskland — Principles of Human-Electric Hybrid Drives for HPVs
This paper discusses the basic configurations of drive systems for human electric hybrid vehicles.
The e-bikes on the market today are parallel hybrids (PHEB, parallel hybrid electric bicycle). In parallel hybrids it is attempted to mechanically add the highly variable torque of a pedalling human with a constant torque of an electric motor. Some vehicles have the motor near the bottom bracket, while others use motors

near or in the front or rear wheel. A special case of a parallel hybrid is Michael Kutters drive system where electric and human power are added using a planetary gearset in the rear wheel hub.
In a series hybrid human electric hybrid (SHEB, series hybrid electrical bicycle) human power is converted into electric power using an electric generator driven by the pedals. Mechanical drive power to move the series hybrid vehicle is produced by a motor driving the wheel just as in the case with the parallel hybrids having either a front wheel or rear wheel (hub) motor.
The different kinds of hybrid drives and their disadvantages and benefits with respect to use in recumbents and velomobiles as well as in upright cycles are discussed.

John Tetz, USA — Light and Quiet Velomobiles with Foam Shell
The question I often get is why Zote Foam? My vehicle design is based on the power that average people can put out – not what the enthusiasts can deliver. I know the market isn't there just yet for average people so I applaud the efforts and interests of the enthusiasts for their support of a relative new industry that is leading us into a much more ecological local alternate transportation system..

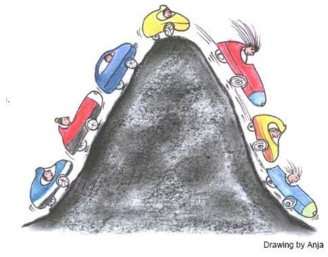
Harald Winkler, Tyskland — 12 kg velomobile made by Meufel-technology
PE-Foam, carbon fibre and sophisticated design make it possible to build a fully enclosed three-wheeled vehicle weighing less than 12 kg.

Heike Bunte, Tyskland — Velomobiles and their Diversification: An Approach towards Greater Acceptance in Societies?
The diversification of products in our societies is like a Janus face. On the one hand it seems that pluralisation brings 'bright colours' and 'great choices' for our lives, and on the other hand it seems that all these 'things' create more complexity than we are able to handle. Sometimes diversity of products seems rather a hurdle than a relief. In addition, we live in the age of extremes, post-modernity or liquid modernity. A unique sign of this age is social and technical acceleration, in which individuals must design their own life rather than count on stable social structures and social governmental policies. Furthermore, the leading key word in our societies is individualisation, which requires a permanent new concept and classification of the "self". With regard to individualisation, the aspect of diversification functions as a means to an end. Also, with diversification the growing aspect of complexity comes into societies which the individual has to manage.

Carl Georg Rasmussen, Danmark — Velomobile aerodynamics – side wind effect and operation limits
The wind and the speed of a velomobile cause aerodynamic forces on the fairing, which can be dangerous under extreme conditions. In order to ride in a safe way, it is important to know the operation limits.
The wind can also be helpful. The sail effect adds to the propulsion even in side wind, where there is a considerable head wind component.
Wind tunnel measurements on different types of fairings give more insight in this phenomena.
In velomobile design it is often necessary to make trade offs of ideal aerodynamics to obtain a practical function. E.g. some fairings use a partly open bottom in order to make better conditions for the cyclist to enter and to get out of the vehicle. How much does it mean to the aerodynamical drag?
This, and other design detailles were studied by measuring the drag on a Leitra velomobile in down hill experiments.

Sylvain Lemoine, Frankrig — Le Vélomobile accessible à tous
Sylvain Lemoine, Diplômé des Arts et métiers en 2001; spécialisé dans les énergies renouvelables en 2002, c'est en menant une recherche sur le mode vie durable que le vélomobil m'est apparu comme un véhicule optimum pour le transport individuel. Dans le cae l'association 2 bien fêteur nous développons le vélomobile pour tous.

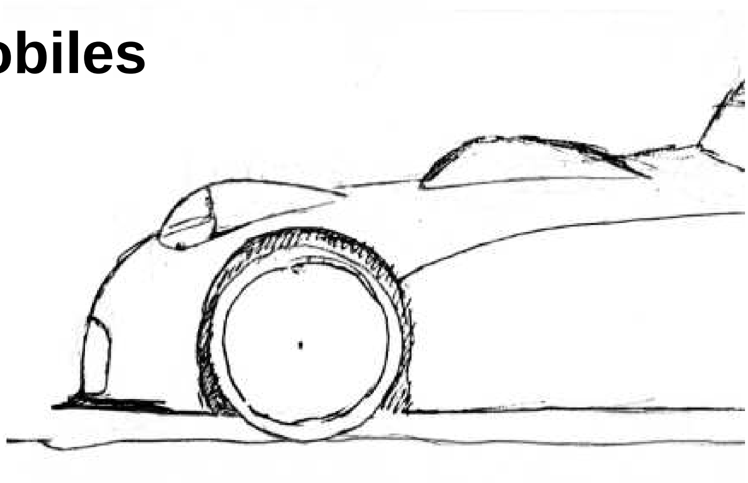
Paulus den Boer, Holland — Velomobiles in traffic
Cyclist experience problems enough around their safety in traffic. So one can expect that exceptional cyclists using velomobiles have even more problems.
Experienced velomobilist Paulus den Boer brings you through a number of practical aspects of traffic safety when riding velomobiles. With clear examples it becomes clear that there is more to know about your own safety than meets the eye!
At the end of the presentation you may have some fresh ideas how you too can take care of your own safety even more than before.



6th European Seminar on Velomobile Design
16.Oct. 2009, Kopenhagen

Four-wheeled Velomobiles

The concept



Ingo Kollibay, Germany
Ingo.Kollibay@saliko.de

Abstract:

Today there is a certain standard in velomobiles:
They are three wheeled, aerodynamically shaped like a drop and mostly have a fairing which is self-supporting. This makes them fast and simple.

The typical disadvantages of this type are limited luggage space, limited braking ability, poor stability against overturning in curves, poor traction in winter conditions and there is always the question where to store it safely.

The concept of the four-wheeled velomobile allows for optimizing every one of these disadvantages with the exception that it is not optimized considering aerodynamics and top speed. Its wider range of abilities makes it more practical for everyday's mobility needs. So there is the chance to reach a much wider range of users, compared to the typical velomobile owner of today.

About the author

Ingo Kollibay, Dipl. Ing. Architekt
Born in 1962 in Hildesheim, Germany

Contact:
Velo.Saliko GmbH & Co. KG
Davenstedter Strasse 60
D-30453 Hannover
Germany
phone: (+49) 511 261 707 0
e-mail: ingo.kollibay@saliko.de

For about 20 Years he has been working as an architect (building and town planning).

Building his own recumbents started in 1983.
Over the years he developed an built many recumbents with long, middle and short wheelbase, tricycles, trailers, folding recumbents, some tandems and special needs vehicles.

Serial products are

- the **Brompton Recumbent Conversion Kit** which makes the Brompton folder to a folding recumbent. Developed together with Juliane Neuss, Hamburg, company Junik Spezialfahrräder who also produced it.

- the running scooter **„Sauseschritt“** (scooter with a saddle), also developed with Juliane Neuss and produced by Patria. Red Dot design award.

In 2002 he founded the company „Velo.Saliko“ together with three other HPV-enthusiasts which developed and produces the circular seven seater HPV **„ConferenceBike“**. The company is situated in Hannover, Germany.
See www.saliko.de and www.conferencebike.de

He is interested in velomobiles for many years, has made a lot of sketches and design studies but does not own one yet.

On the 5th Velomobile Seminar held in Germersheim in 2004 he gave a lecture on the Cyclodyne, a forgotten early velomobile from the US.

Co-Author
and also lay out

Juliane Neuß, Material Science
Born 1962

Contact:

info@junik-hpv.de
www.junik-hpv.de

Juliane Neuss developed the “growing” children´s-Bike SKIPPY in 1994, which is built by PATRIA. She also developed the Brompton Recumbent Kit and the running scooter “Sauseschritt”.

She is specialized at bike ergonomics and has started to write a book about it.

Her One-woman-company Junik is running since 1998 with the Brompton Recumbent, with 8-Speed Bromptons and special bike constructions, but she is still working as a Technical Assistant for Material science in a small Labaratory at the University of Federal Armed Forces in Hamburg.

Four-wheeled velomobiles

The concept

1. The shape of today's velomobiles

The velomobile of today has spread mostly in the appearance of the three-wheeler, with two steered wheels at the front and one driving wheel at the rear.

This wheel arrangement permits the full fairing to be a drop-shape, seen from above. So a low drag can achieved and such velomobiles can be optimized in aerodynamics. They reach speeds up to 70 kph in races.

Photo: www.velomobiel.nl

Most of these velomobiles have a fairing which is self-supporting to save the weight of a frame. And the general technical arrangement in particular the drive train are rather simple and cheap.

Other types of wheel arrangements usually have not been regarded as velomobiles so far:

- One driving wheel in the front (pedals in front of the wheel), two rear wheels. Articulated frame, mostly without fairing. Example: Flevo Trike.
- One steered front wheel in front of the pedals, two rear wheels, one or both driven. Example: The ultra-lightweight velomobile of Harald Winkler, presented in this seminar, too. But mostly there is no fairing or only partial fairing.

The reason of success of the drop-shape is of course high speed, achieved by good aerodynamics.
And in addition the drop is a very simple, basic shape which is considered as self-evident and „perfect“.
So this type of velomobile is perceived as a new and self-contained type of vehicle between bicycle, motorcycle and car. There is just no other type of vehicle that looks like a drop.

2. Common disadvantages of three-wheeled velomobiles

The drop shape which makes the three-wheeled velomobile so successful leads to several disadvantages. It is only a compromise in many other aspects:

- Stability against tipping sideways in curves is limited.
- Braking ability is limited because the center of gravity is closely behind the front wheels.
- There is rather poor traction on gravel paths and in winter conditions because only ca. 30% of the weight bears on the rear driving wheel.
- The drop shape leaves only little space for luggage.
- When the fairing is self-supporting there is no possibility to weaken it by a large access hatch. So getting in and out through a rather small opening is neither comfortable nor quick.
- Transport over stairs and storage indoors or even in cellars is difficult or impossible because the fairing is so bulky and long.

Is there a different type of vehicle that is a compromise in fewer and other aspects?

3. The four wheeled Velomobile

The concept of the four-wheeled velomobile allows for optimizing every one of the disadvantages or compromizes of the three wheeled velomobile, with the exception that it is not optimized considering aerodynamics and top speed.

It has a wider range of abilities which makes it more practical for everyday's mobility needs. So there is the chance to reach a much wider range of users, compared to the typical velomobile owner of today.

On the following pages there is made the comparison of the four-wheeler to the three-wheeler in the essential aspects.

The comparisons are only schematic, just to show the principles of the concept. Compared are the following aspects:

- typical dimensions
- safety
- (cornering) speed
- braking ability
- traction
- luggage capacity
- storage

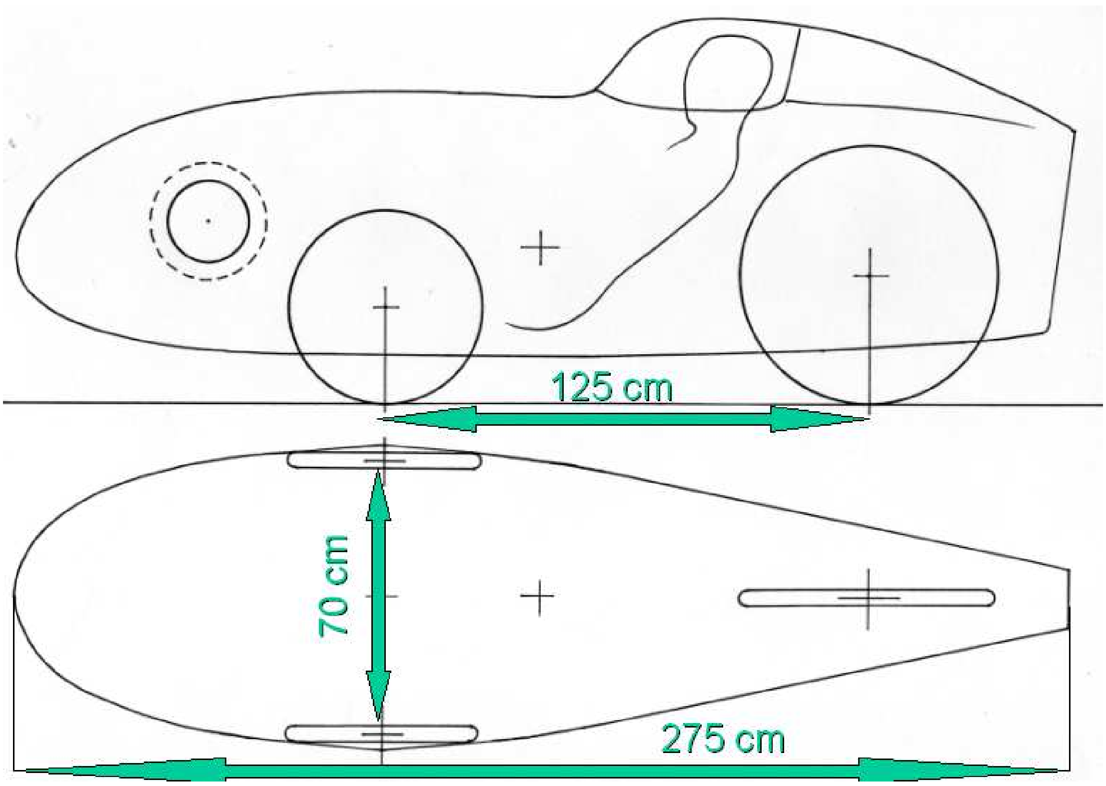
There is no comparison made, however, in other technical aspects or details, as

- material of the fairing
- head out, or canopy
- mirrors
- lighting
- suspension
- wheel sizes
- wheels inside the fairing and covered / inside but uncovered / outside of the fairing
- drive train
- ventilation
- etc.

because they are not distinctive for only one of the types.

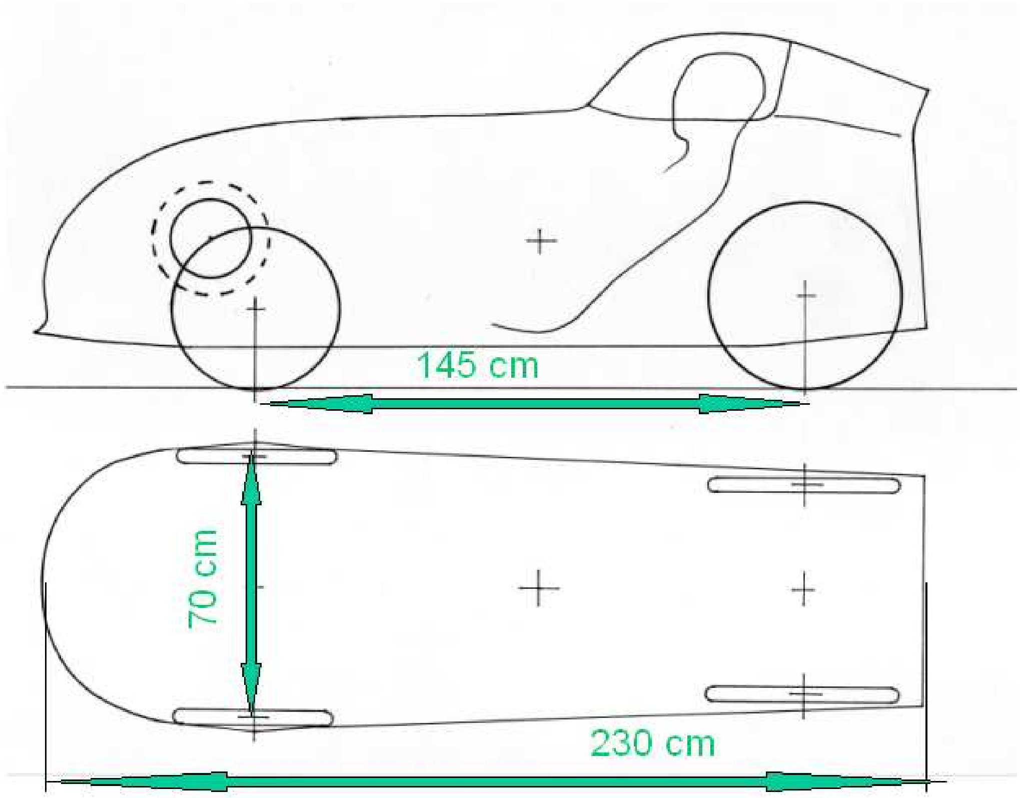
4. Typical dimensions

In my comparison I set the track width of the front wheels of the three- and the four-wheeler equal, 70 cm.



The wheelbase of a three-wheeled velomobile is rather short, about 110 to 130 cm.

The overall length of its fairing, however, is rather long, up to 280 cm.



The wheelbase of a four-wheeled velomobile can be (and should be!) much longer, up to 150 cm.
The fairing does not need to be much longer than the wheelbase, for example 210 to 230 cm. So the overall length is considerably shorter.

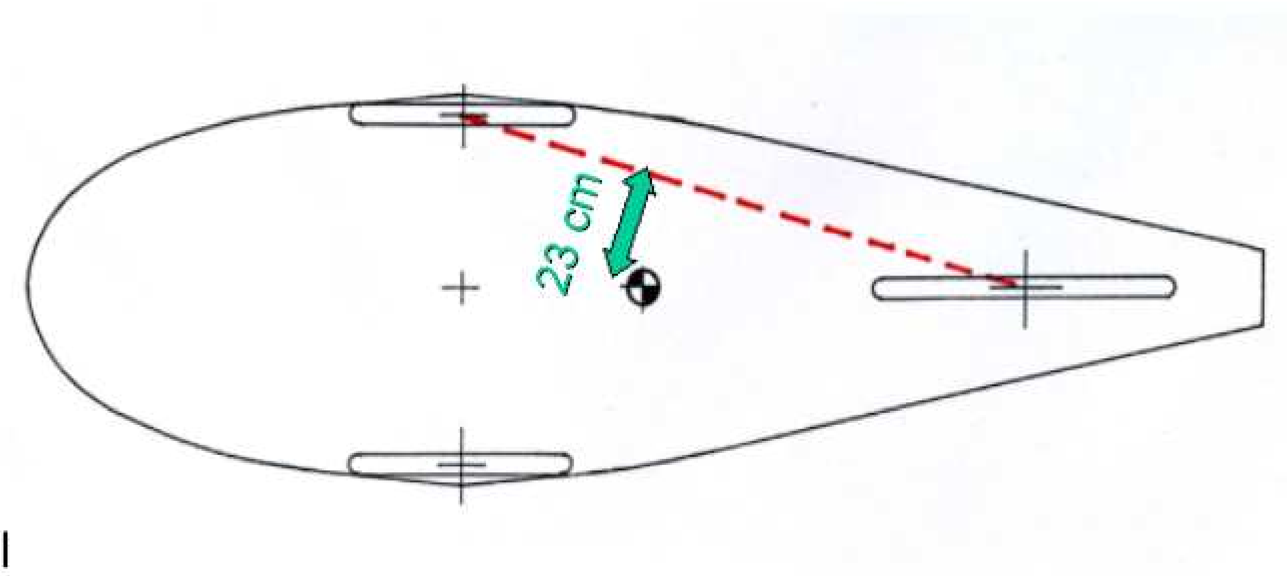
5. Safety / road holding

The three-wheeled velomobile is always a compromise in safety.
When the front wheels are arranged far ahead it will brake well but is not very stable against overturning in curves.
When the front wheels are arranged more to the back, near the center of gravity, safety against overturning is much better but braking abitity is poor. It will lift its tail easily.

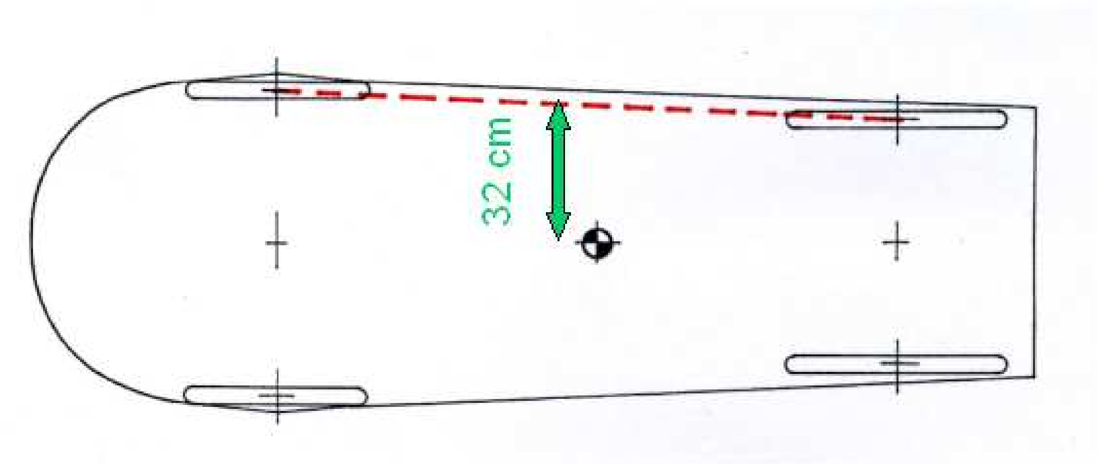
The 4-wheeler can be optimised for both aspects:
It can apply both considerable braking power AND is very stable in tight and fast curves as well. This is achieved by the front wheels arranged much more forward and a rear wheel track which is equal or only a little narrower than the front wheel track.

Maximum stability against overturning is provided by the fact that a four wheeler can employ its full track width. A three wheeler has an „effective track width“ which is narrower than its track. Compared to a 3-wheeler of the same width the 4-wheeler is less likely to turn over.

And with its longer wheelbase it will run more smoothly and less bumpy and nervous at higher speeds.



Three-wheeled velomobiles are not as stable against overturning as they seem to be, regarding their track width.
They will tip over a line which runs from one front wheel contact point to the rear wheel contact point. This is the „tipping line". Its effective width is not the track width but its width near the centre of gravity. So the effective width is only 70 to 60 % of the track!



Four-wheeled velomobiles of the same track width of the three-wheeler are much more stable against overturning. The tipping line equals the track width.

6. Speed / energy efficiency

What does speed mean? Is it the top speed?

In daily use speed is only a means to get from A to B. The time it really takes to get from A to B depends on average speed.

High average speed is not necessarily guaranteed by reaching maximum speed.

But the most efficient means to rise the average speed is
to avoid to be slow!

Because of its higher stability in curves the 4-wheeler can also corner with higher speeds!

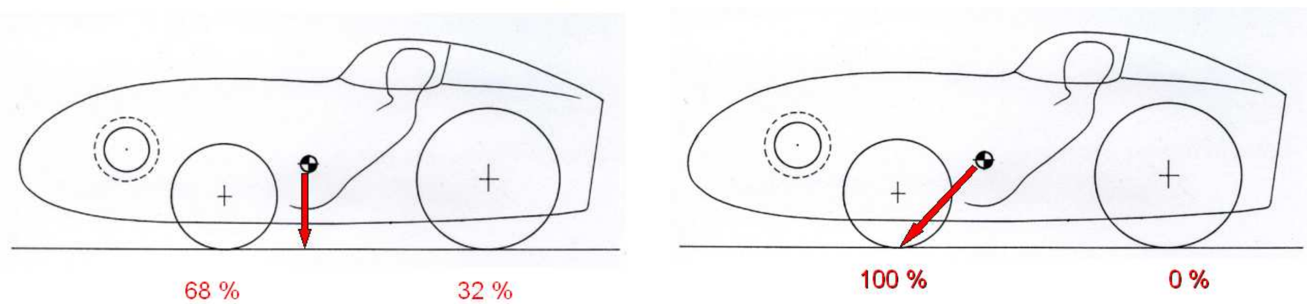
In addition it is possible to arrange the track so wide and the centre of gravity so low that a four-wheeler will no more turn over in curves but merely slips away sideways, even on tarmac. This would be a crucial gain in safety!

With the ability of a higher cornering speed it is not necessary to decelerate so much before curves. After the curve it is more efficient to accelerate from e.g. 20 kph to cruising speed again, instead from e.g.15 kph.

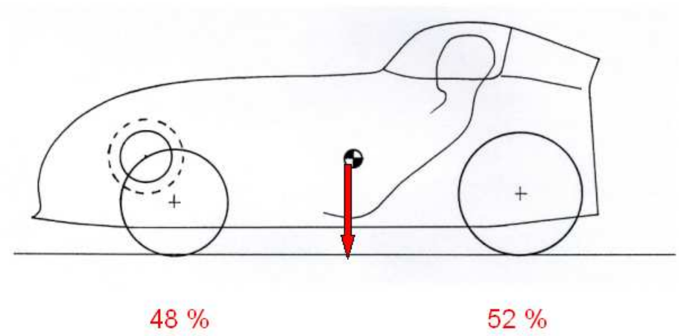
This **saves a lot of energy** and leads to a **higher average speed.**

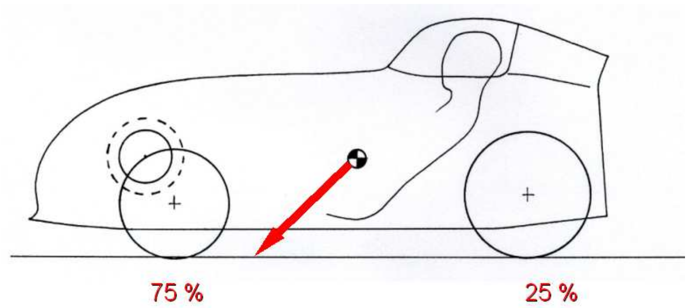
But this always depends on how many and how tight curves are on the typical route, of course.

7. Braking ability



Position of centre of gravity in three-wheeled velomobiles. Typical distribution of wheel loads.
Distribution of wheel loads when braking: At maximum deceleration nearly all the weight bears on the front wheels. Danger of lifting the rear wheel and losing directional stability.

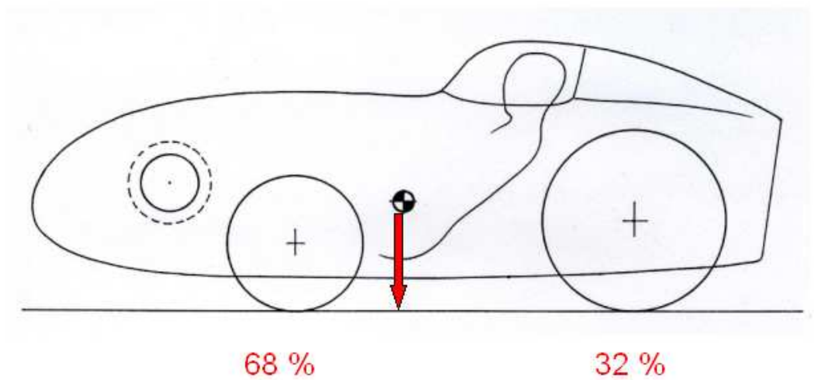




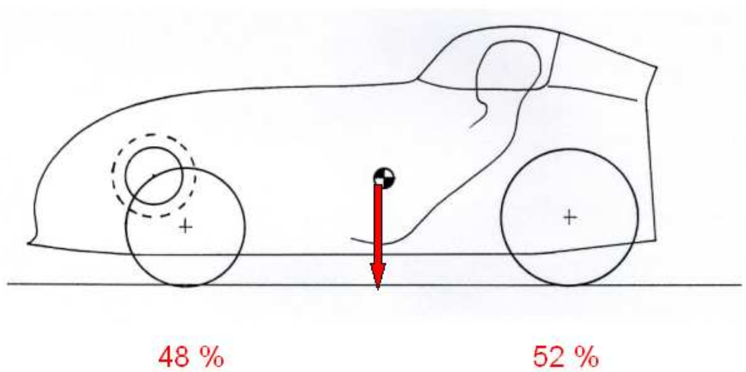
Position of centre of gravity in four-wheeled velomobiles. Typical distribution of wheel loads. More load on the rear wheels than on the front wheels.
Distribution of wheel loads when braking. There is always enough load on the rear wheels. So maximum deceleration can be transferred to the ground without the danger to lose directional stability.

Optimised braking can be achieved by positioning the front wheels much more to the front. This allows to transfer maximum braking power to the ground through front and rear wheels.

8. Traction

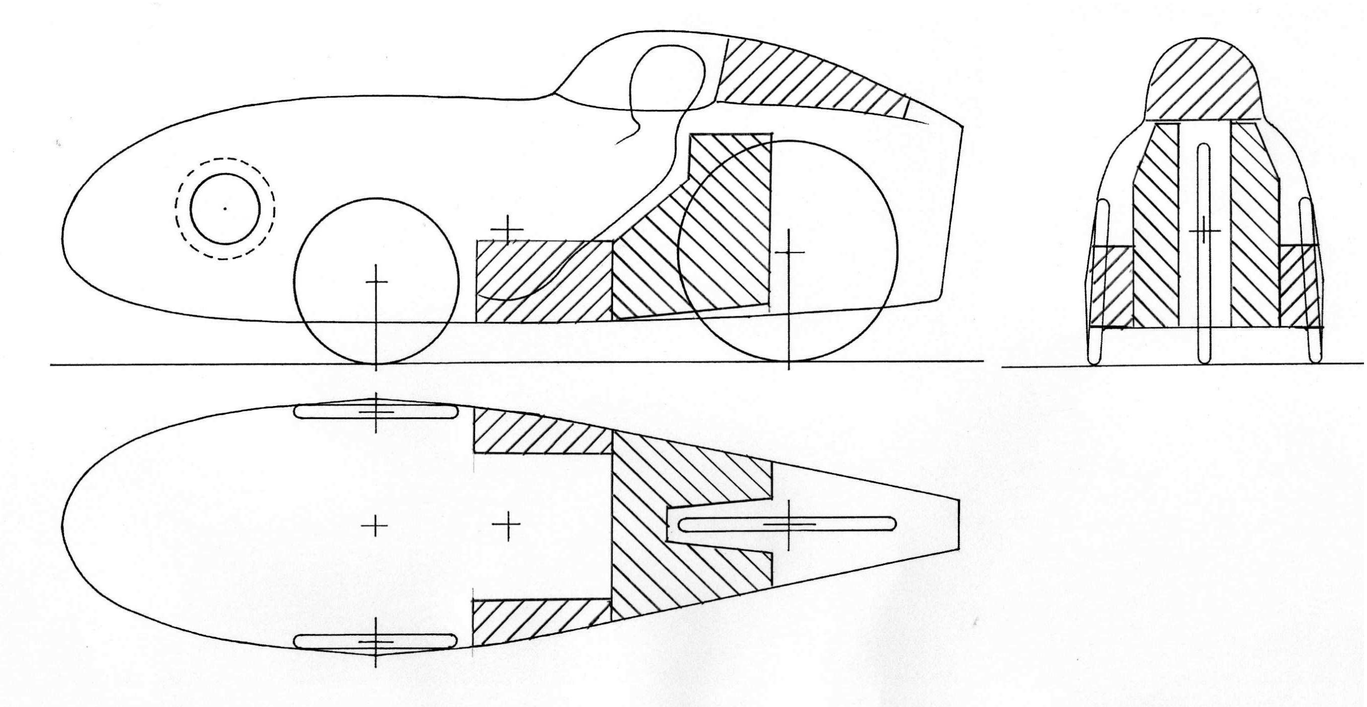


Traction of three-wheeled velomobiles. Only a small percentage of the weight bears on the driving wheel. Poor traction on loose ground and in winter conditions.



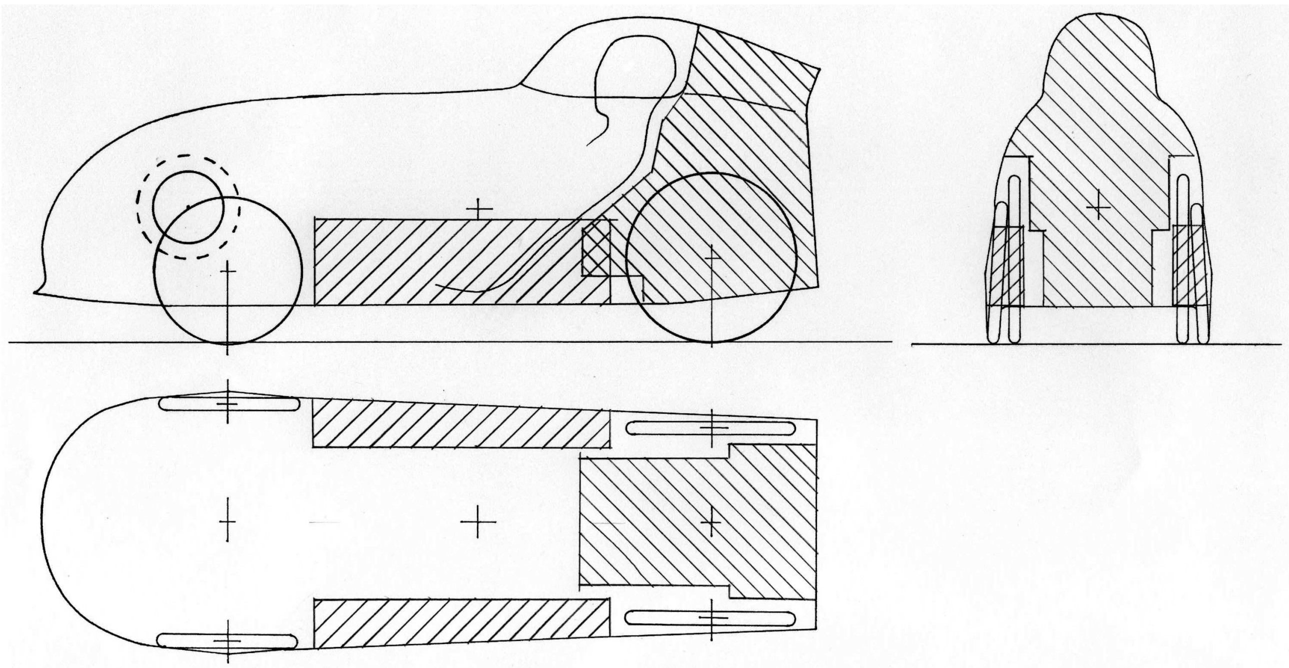
50 to 70 % of the weight are bearing on the driving rear wheels. This results in good traction on loose ground and in winter conditions which makes the 4-wheeler an all season vehicle.

9. Luggage capacity



Typical luggage capacity of three-wheeled velomobiles:

By the drop shape of the fairing there are only leftover volumina available for luggage.



Typical luggage capacity of four-wheeled velomobiles:

Between the two rear wheels there is lots of space available in **one** luggage compartment. This can pick up for example one or two crates of beverages, shopping, luggage or a child's seat. This makes it a competitor to the car!

10. Getting in and out / comfort / acceptance:

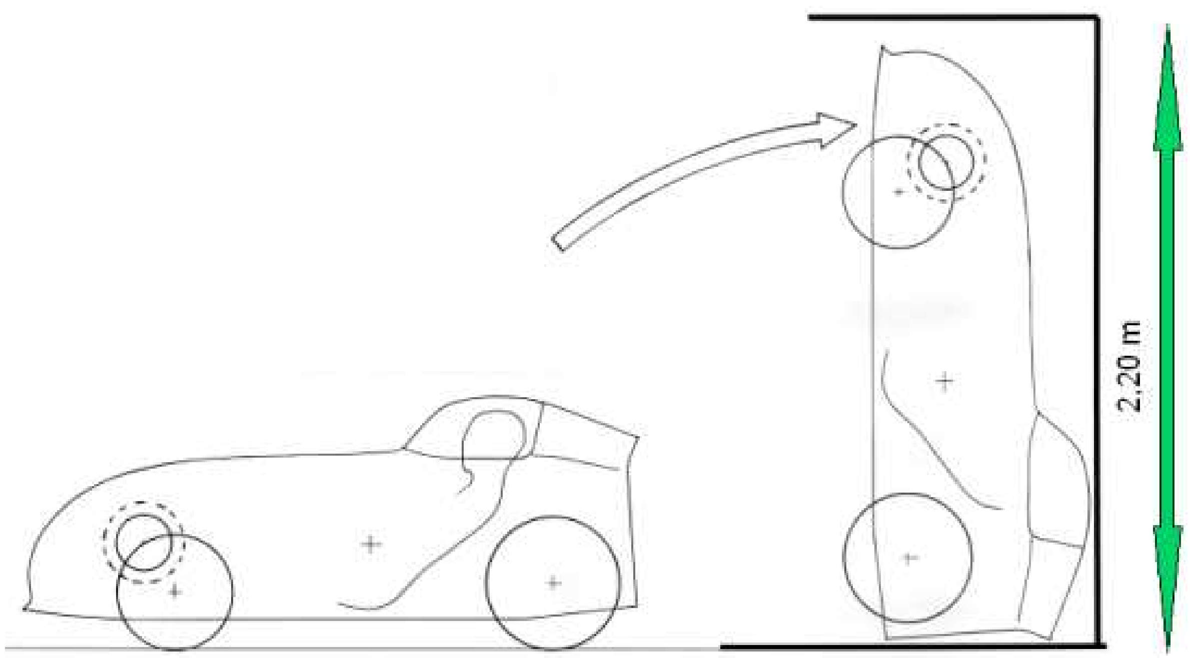
In three-wheeled Velomobiles in a self-supporting fairing getting in and out through a rather small opening takes some time and may not be accepted by less agile people.
May be in some cases this reason is the only reason why people don´t buy a velomobile!

If the fairing is only a fairing and the frame is the main structure, the fairing can be opened wide. So very easy access can be provided. Thus more (elder) people which are less agile (but have enough money) can accept to use a velomobile!

Also shopping tours with many stops become much more attractive if getting in and out is quick and easy. This is a very important point to integrate velomobile use into daily life!

11. Storage

A 4-wheeler has a cut off rear end and can be built short (down to 2.0 m). Both features allow to store it vertical, sitting on its tail, even in cellars or trains.



12 Shape, design and acceptance

The drop-shaped three-wheeled velomobile has been successfully installed in public perception as a self-contained shape. It is a new but distinctively different type of vehicle between bicycle, motorcycle and car.

If someone encounters a drop-like vehicle he can assume: This must be a velomobile.

For the four-wheeled velomobile things are much less settled.
By the four wheels it resembles the car.
In its perception there is always the danger to be mistaken as a toy-car or a pedal-car because it is small. And so even to be a bit ridiculous in some people's minds.

Concerning acceptance it seems to me that there are two opposing views on the vehicle:

Many people who are practising an ecological and sustainable way of life reject „the car“. They (try to) substitute it by bicycle, recumbent or velomobile. Maybe they would reject a four-wheeled velomobile, too, because in their opinion it comes too close to the disliked car. They would perhaps accept only the three-wheeled velomobile.

On the other hand there are many car-driving people who would not want to be seen on a recumbent or on a three-wheeled velomobile. For them this is too „eco“ and too „alternative“.
So they are more likely to accept a four-wheeler as an alternative to the car and as a „green“ means of transport. Here is the potential of a new group of customers who wouldn't buy a three-wheeled velomobile but perhaps a four-wheeled one. There is a chance that car-users change their vehicle. This still has to be verified.

Crucial to the success of the four-wheeled velomobile is to solve its yet unsettled perception.
This can only be done by **design!** A distinctive shape still has to be developed.
The four-wheeled velomobile must look

- cool !!!
- like a racing car
- promising prestige
- and it must be practicable and useful in daily life **at the same time**.

On the following pages there are some examples how the few existing four-wheeled velomobiles look like.

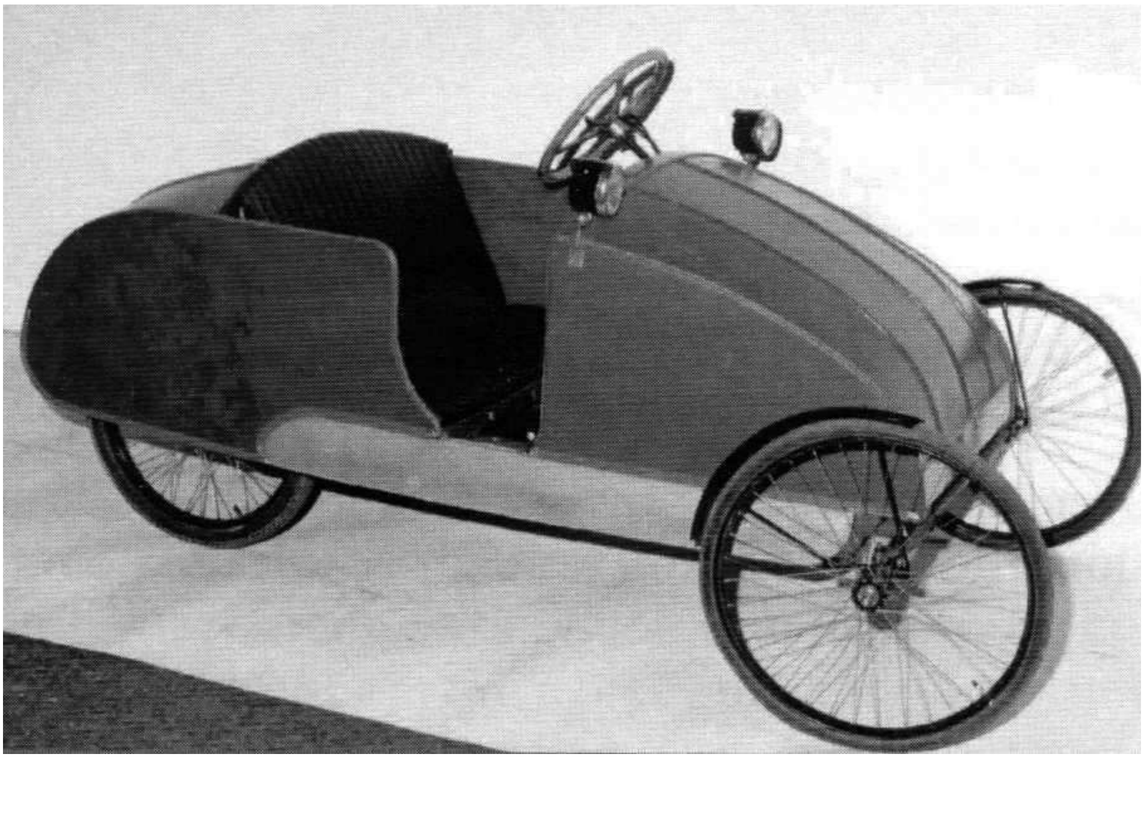
After that there are some design studies about the shape of future four-wheeled velomobiles.

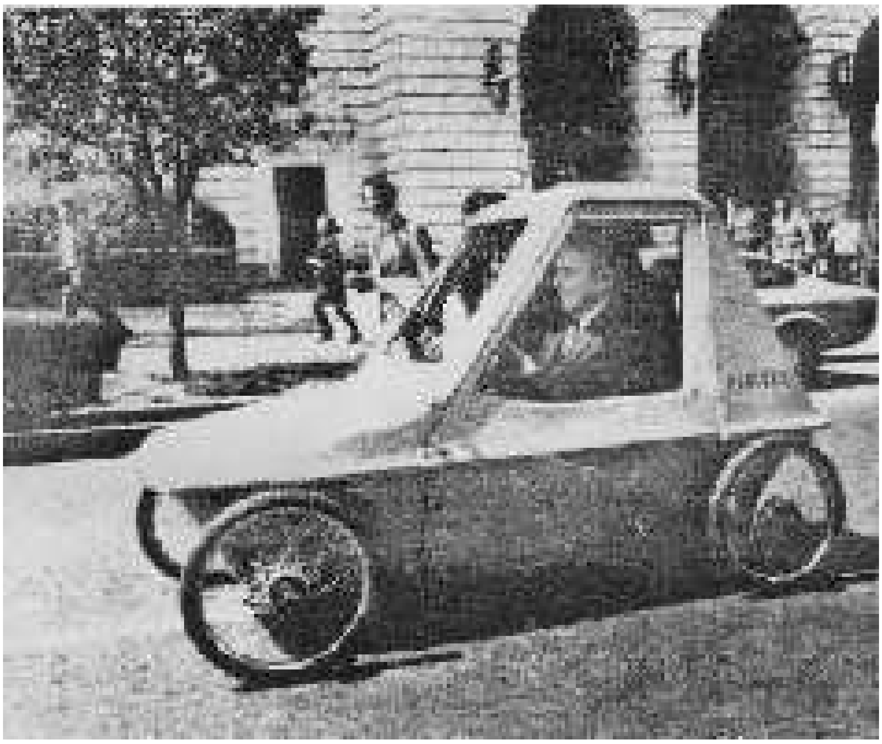
Curry Landskiff
Manfred Curry, Germany 1926
Rowing drive, also available as unfaired tandem

Hulton-Archive, Internet

Mochet „Velocar“ , France
over 1000 produced between
ca. 1927 and ca. 1948

Pictures: Radfahrgalerie
Burgdorf, 2004





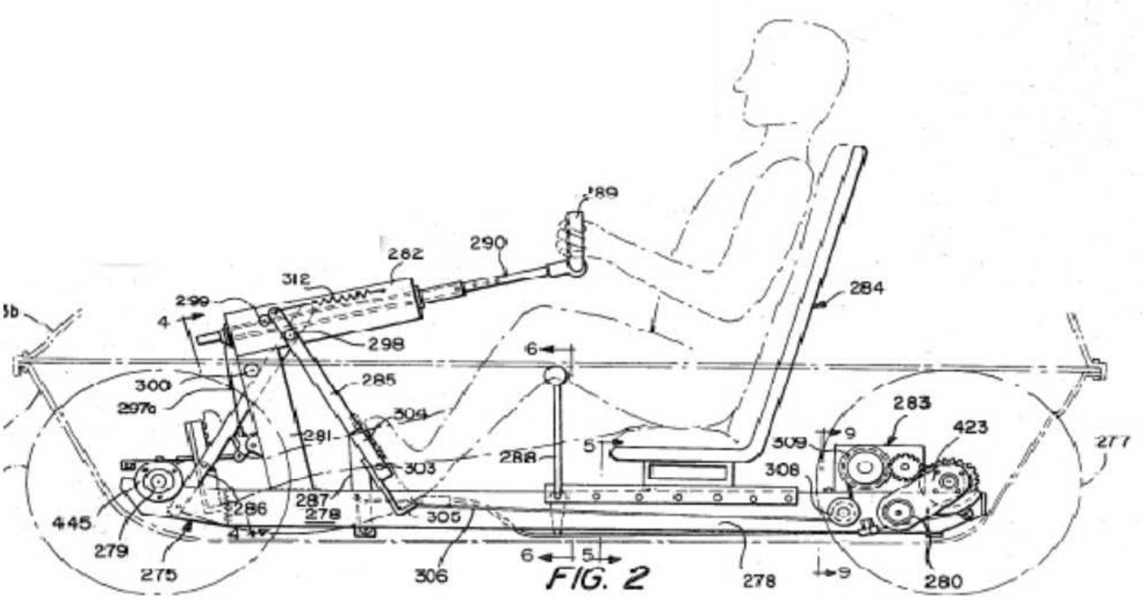
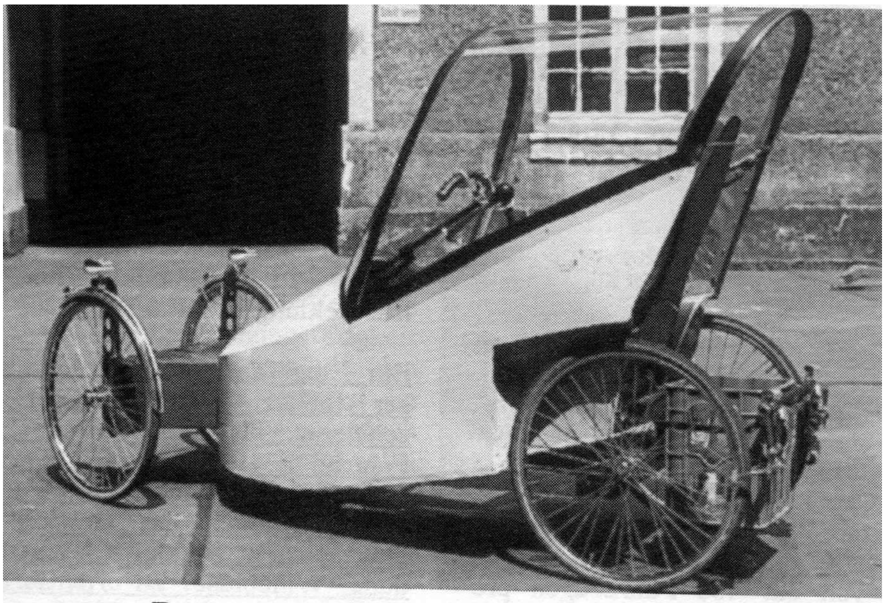


FIG. 2

Robert Bundschuh, 1974 USA
hanging lever drive, 5 gears,
no hub gears

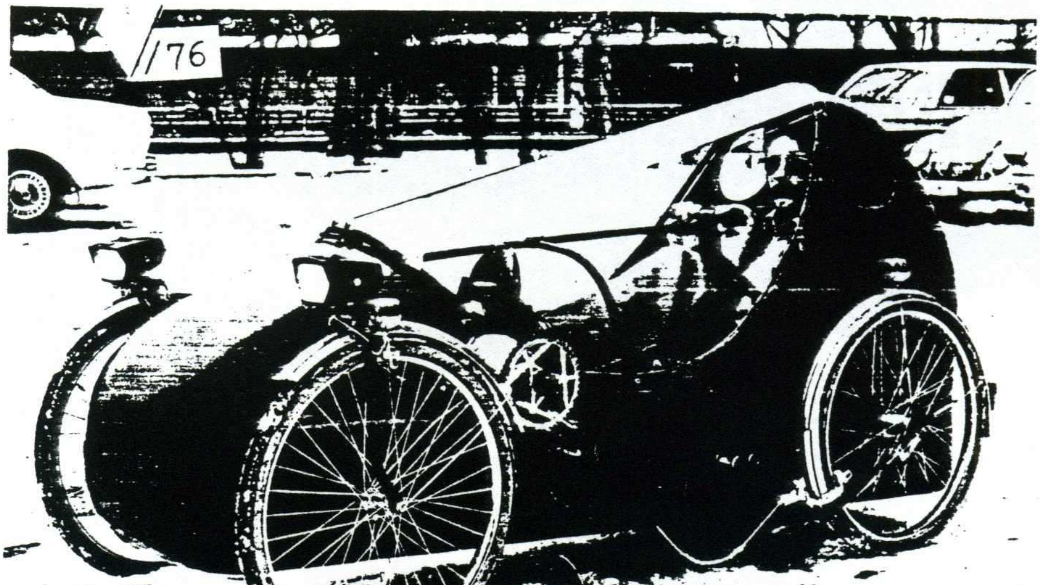
Pictures: www.geocities.com



Tourenmuscar 1975 Dipl.-Arbeit Herr Krahn

Photo: HPV-Chronik, 10 Jahre HPV

„Muscar“, FH Köln, Prof. Schöndorf, 1975



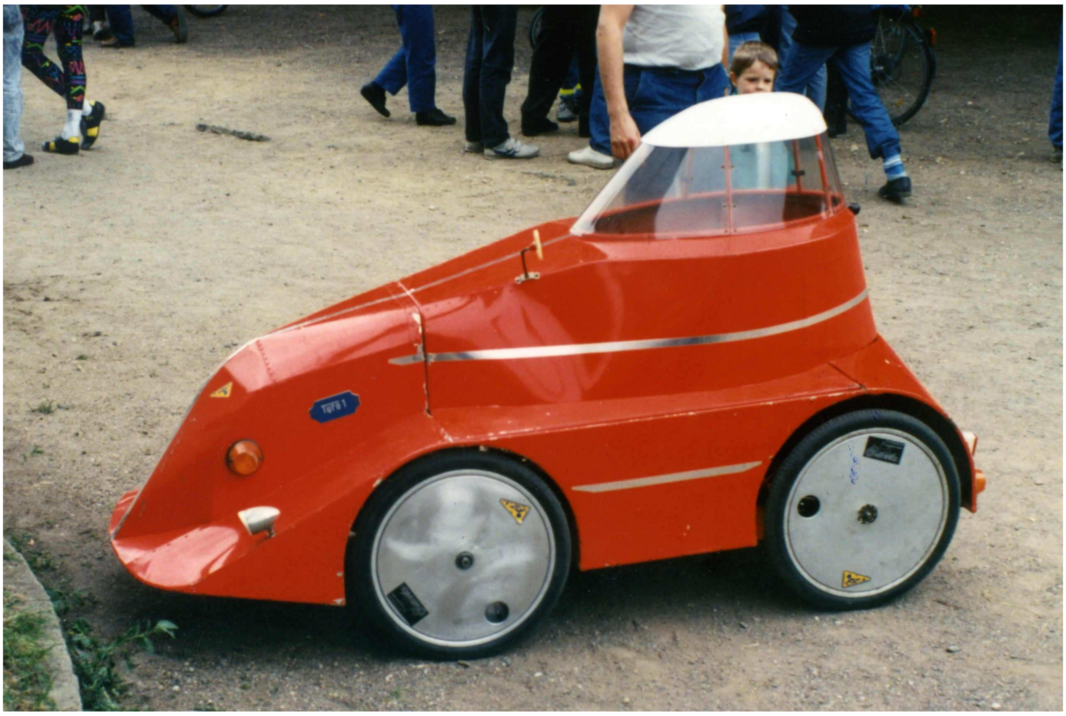
„Muscar“ 2, FH Köln Prof. Schöndorf, Germany ca. 1976

Muscar Schöndorf-Huxel-Henke. Das 2. Muscar
Selbsttragende GFK- Karosserie, Kurbelwelle
statt Tretlager, 24"-Räder, alle gefedert.
Sehr aufwendige Konstruktion, es hat sich
gezeigt, daß man auf einen Innenrahmen nicht
verzichten kann, sonst treten beim Fahren
starke Verwindungen und Schwankungen auf.
Gewicht 45 kg.

Picture: Gerhard John Liegerdreirad-Katalog 1985

„Alternativer Leichttransporter“ AL 2 of Union Fröndenberg and
Luigi Colani,
Germany 1982

Pictures „Radfahren“ 5/1982

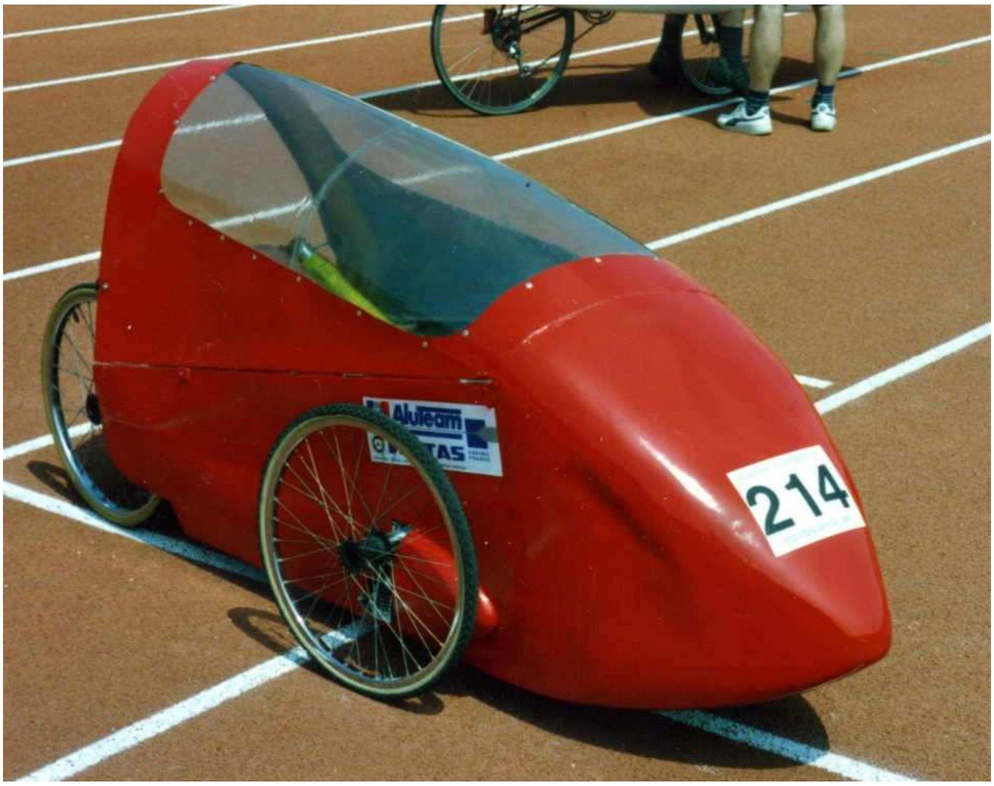


Photos: Heiko Stebbe, Germany

„Turo“
Paul Rinkowski
DDR 1984

Photo: Ingo Kollibay

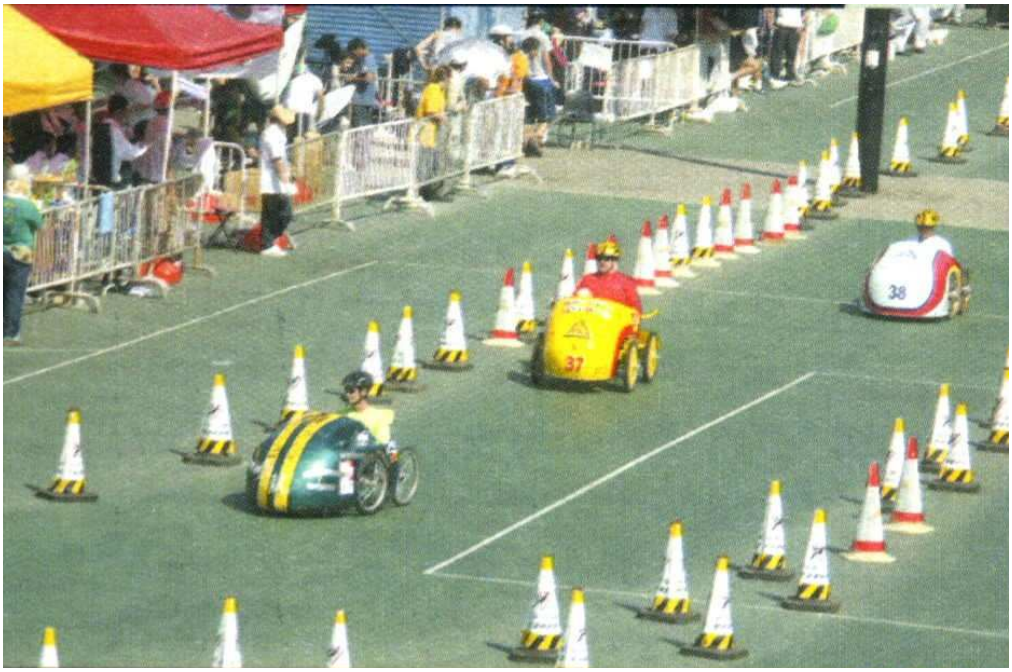
Photos: Ingo Kollibay



French four-wheeler
seen in Wolverhampton
ca. 1992

Kingsbury Racing
Velomobile, GB
With linear drive and
four-wheel steering
ca. 1990

Photos: Heilko Stebbe, Germany



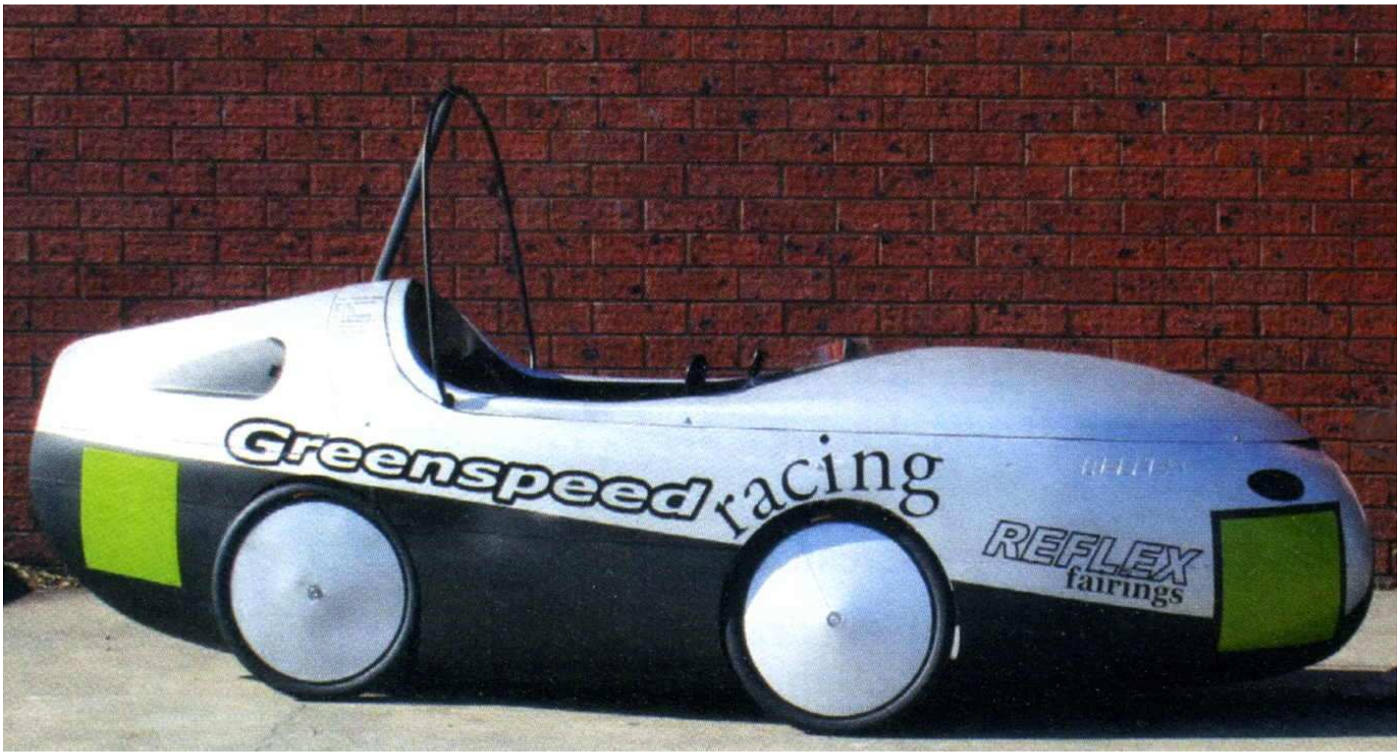
Picture: Velo Vision 17, 2005

Pedalcar racing in Hong Kong, 2005
Hong Kong Human Powered Vehicle Association
www.hkhpva.org

2006 BRITISH PEDAL CAR CHAMPIONSHIP EVENTS

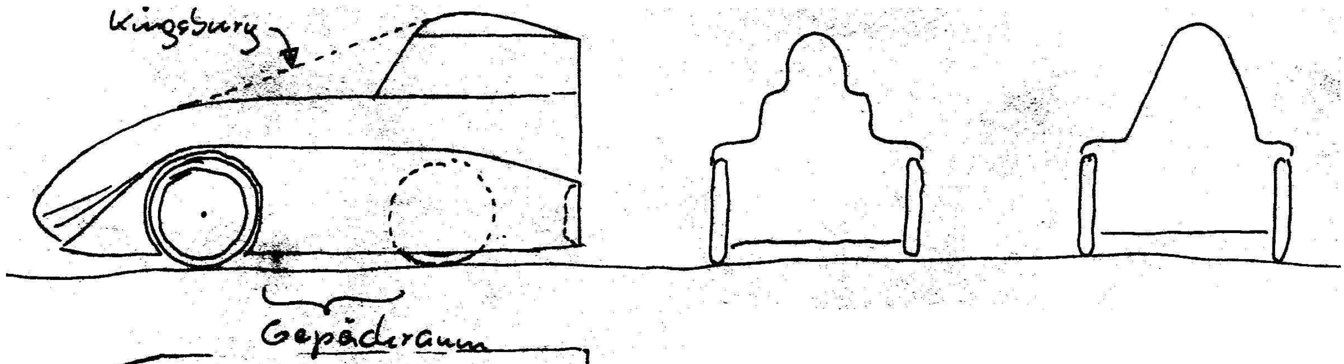
Picture: Velo Vision 21, 2006

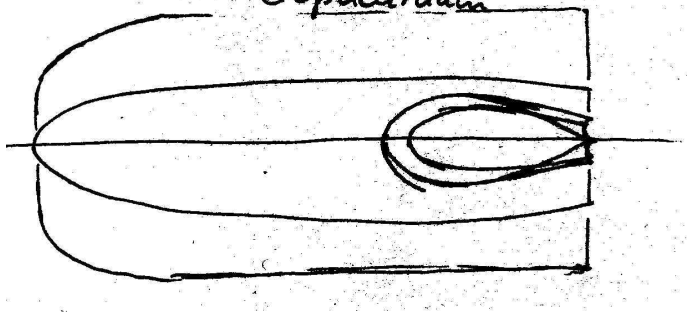
British pedal car, 2006
www.pedalcars.info



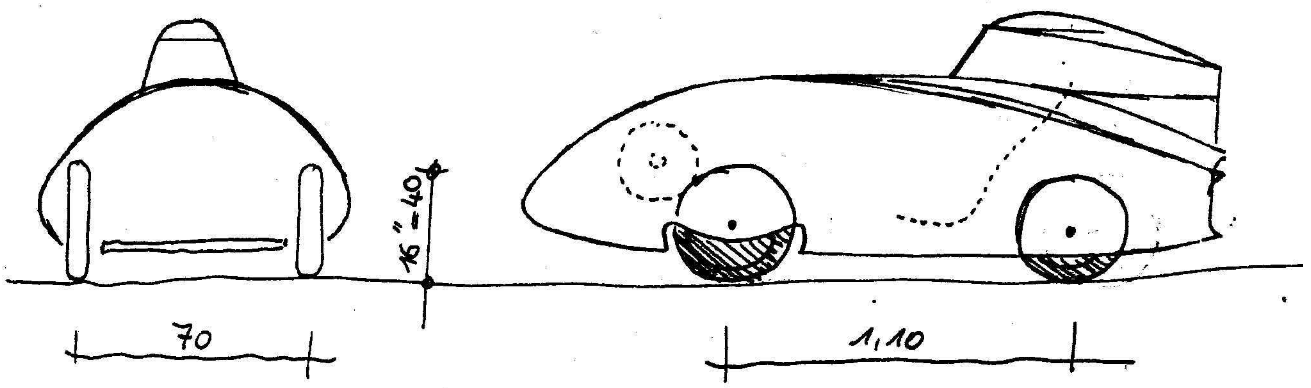
Picture: Velo Vision 21, 2006

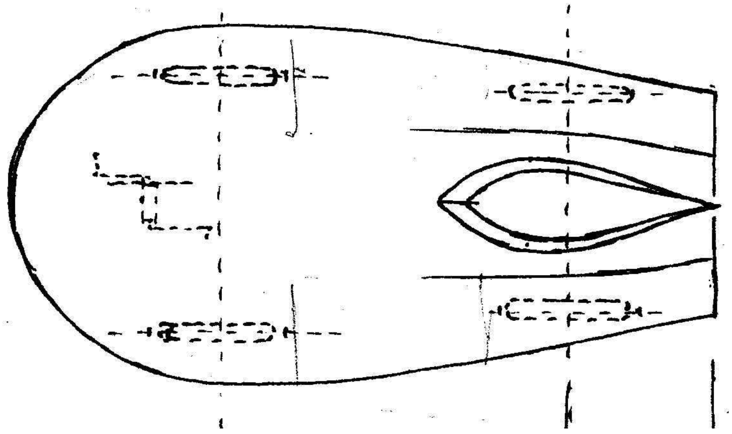
Greenspeed four-wheeled racing velomobile
Australia, 2006



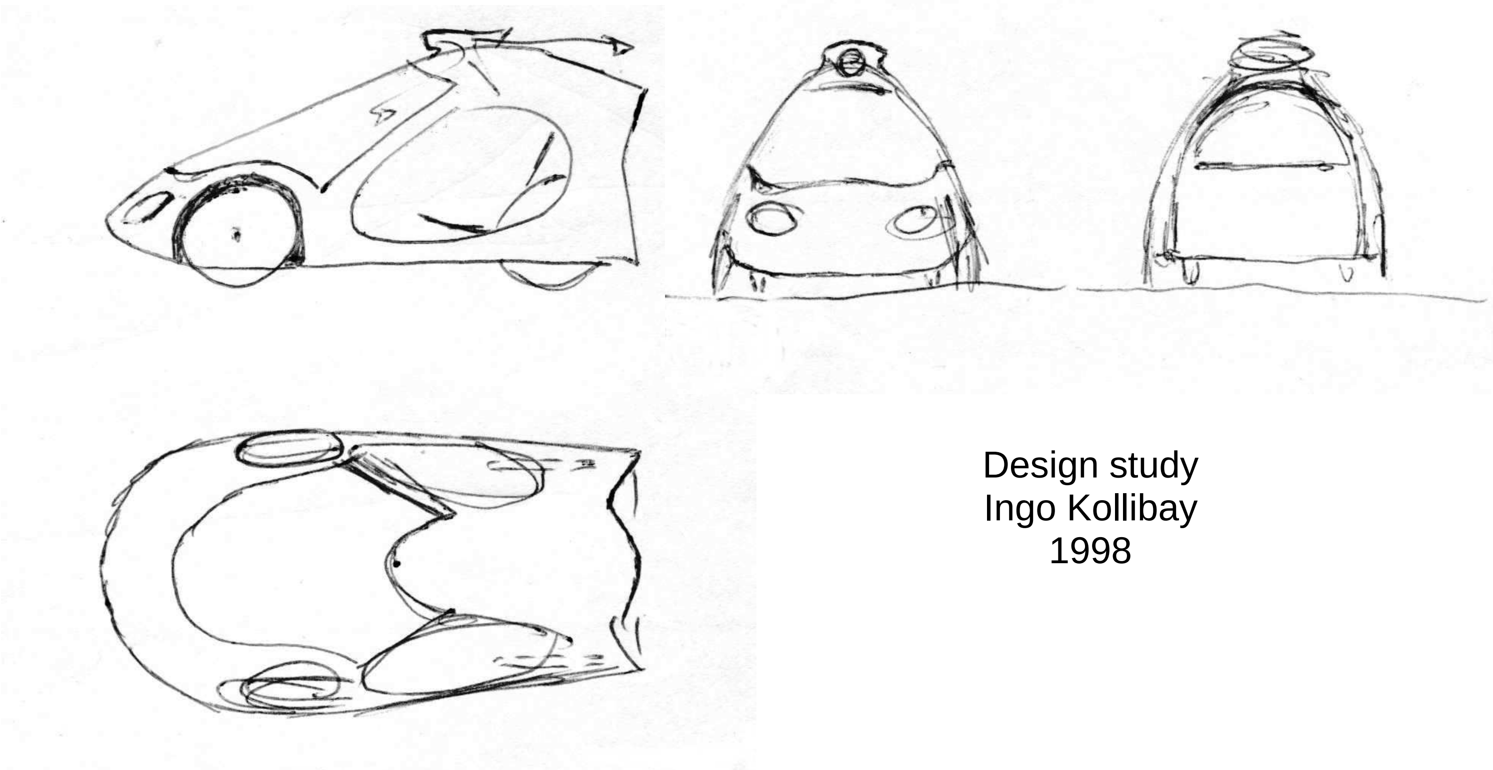


Design study
Ingo Kollibay
1996

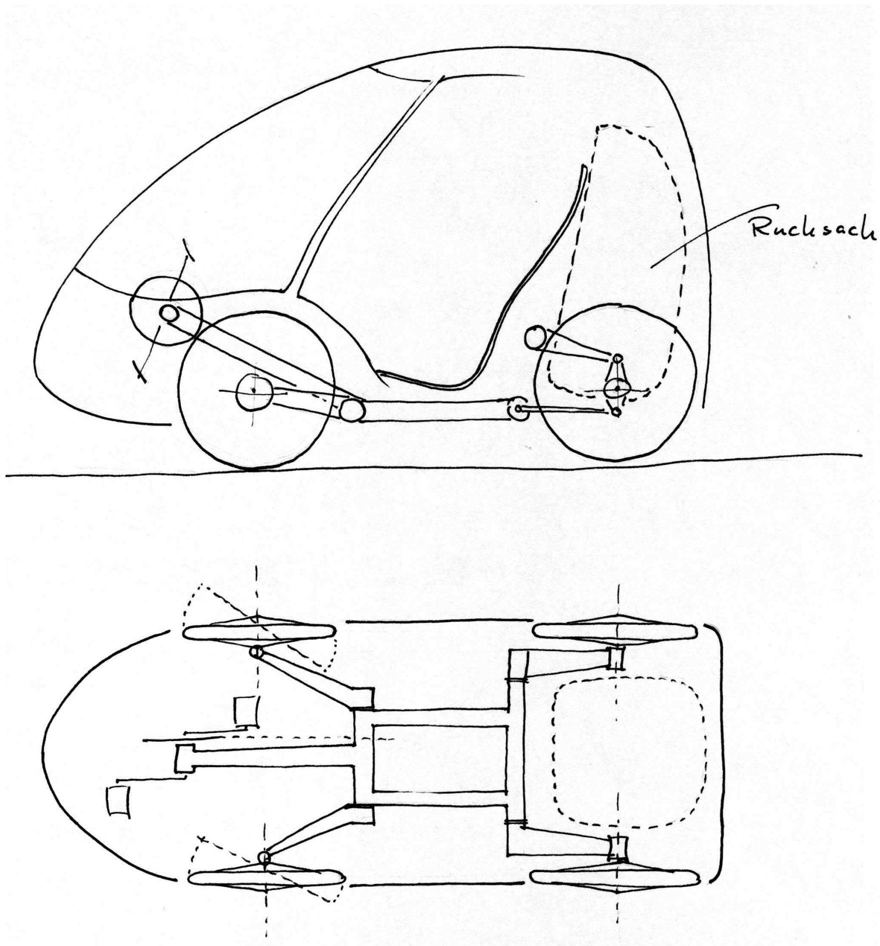




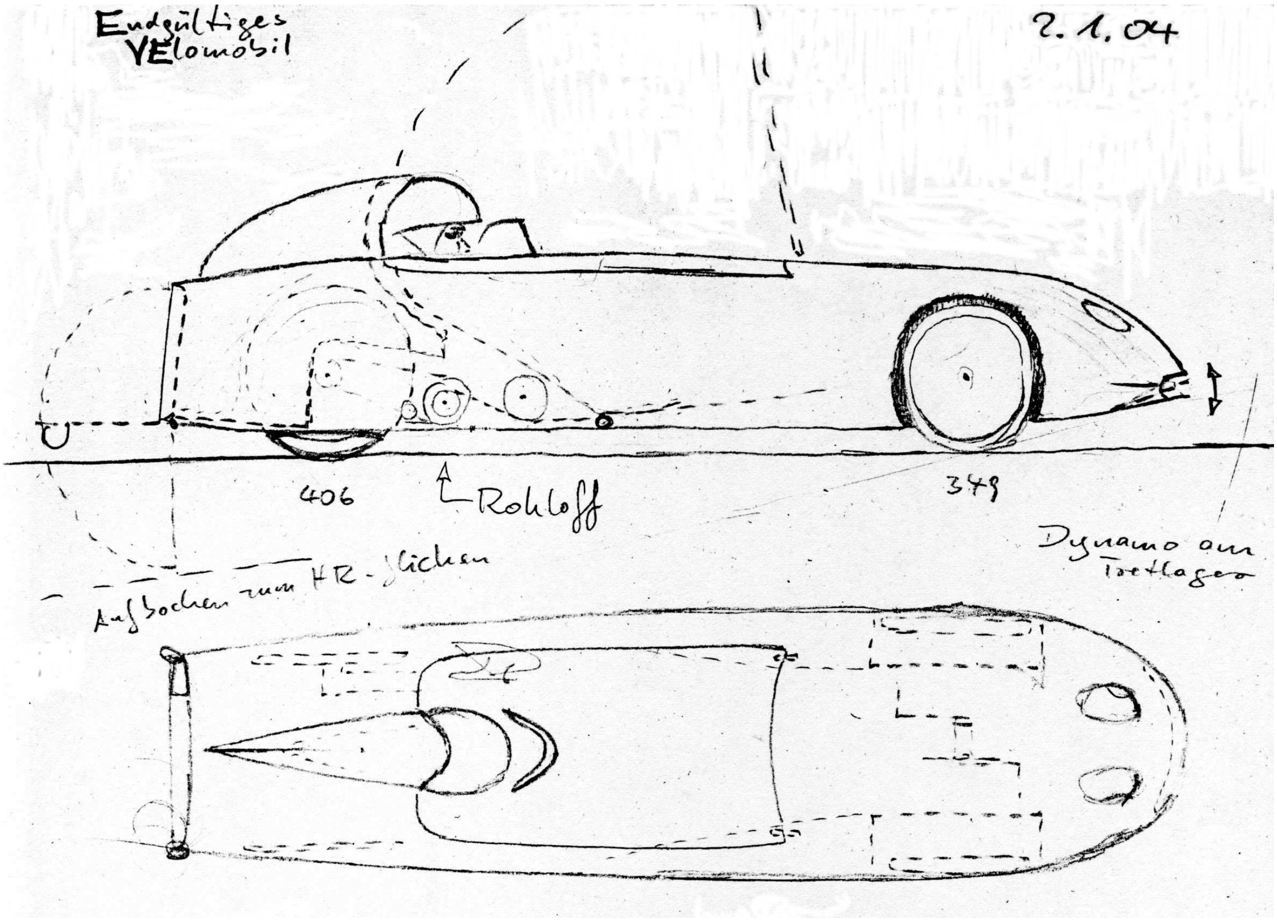
Design study Ingo Kollibay 1996



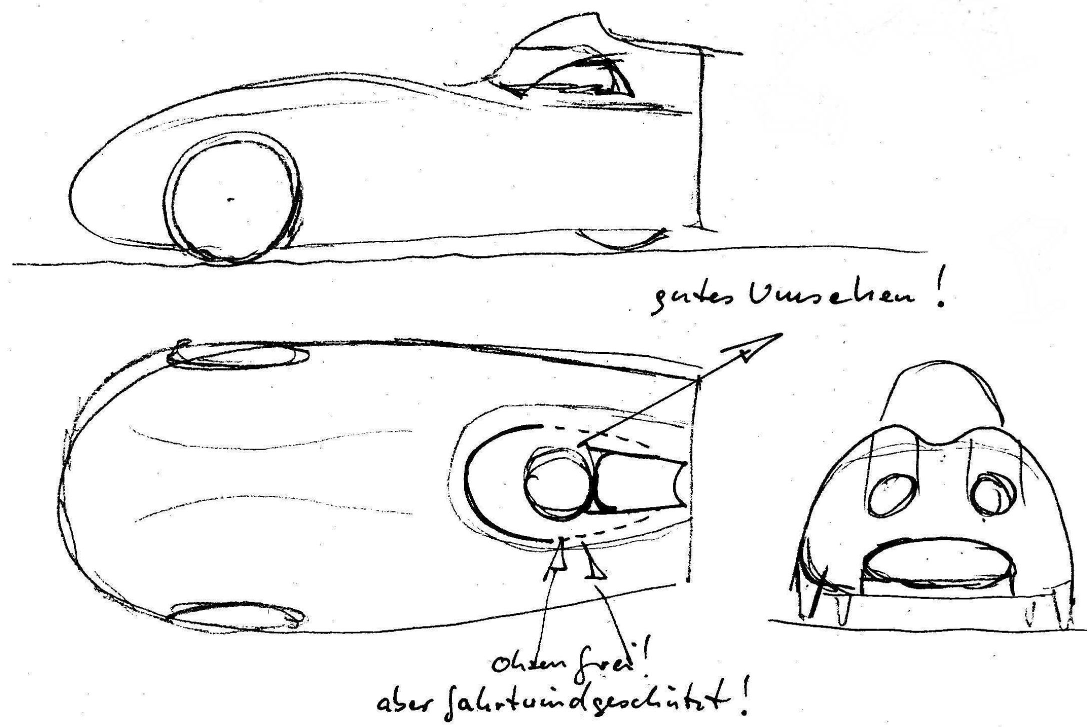
Design study
Ingo Kollibay
1998

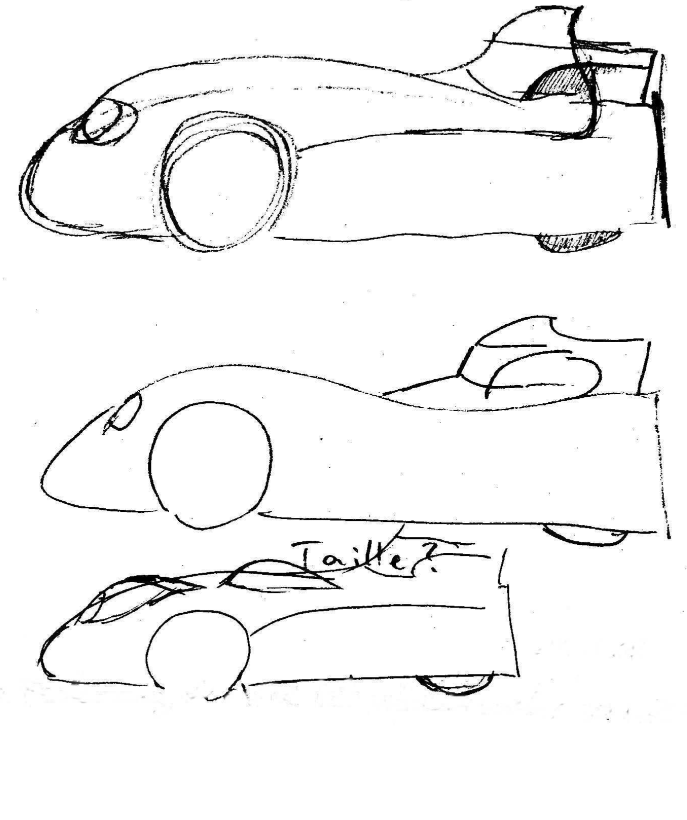


Design study
1996
Harald Kutzke
Ecomotion Design
ecomotion.com

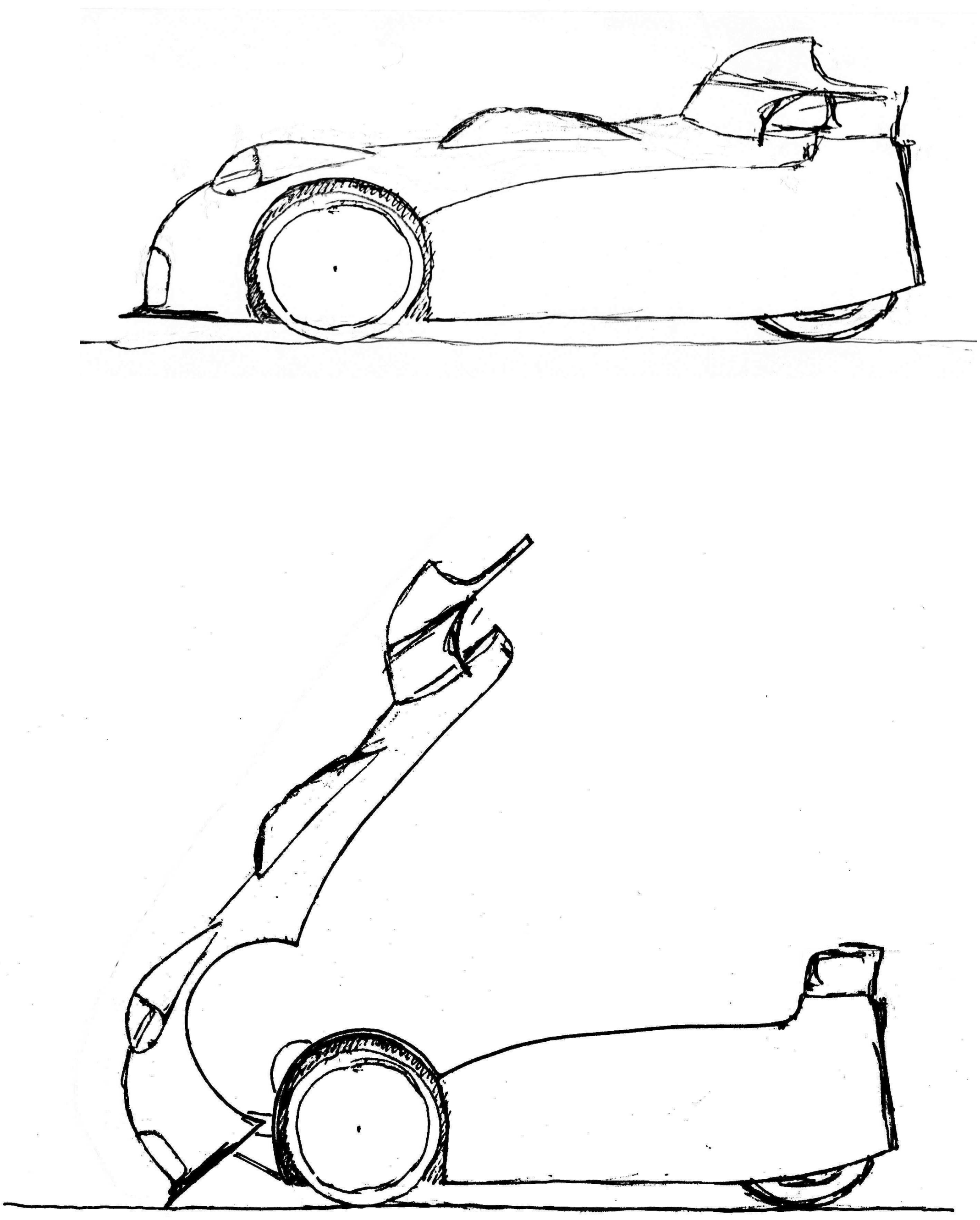


Design study Ingo Kollibay & Juliane Neuss 2004





Design studies
„racing car“
Ingo Kollibay
2008



Design study „racing car“ Ingo Kollibay 2008

13. Conclusion

The four-wheeled velomobile is more versatile than the three-wheeler, it is an allrounder.

It has a wider range of abilities which makes it more practical for everyday's mobility needs. It can perform several jobs which people usually „need“ a car for.

So there is the chance to reach a much wider range of users, compared to the typical velomobile owner of today.

The four-wheeled velomobile is the real

Sports
Utility
Vehicle **!**

Antal Joó dr. – Gábor Joó:

Possibility and Situation of Velomobile Riding in Hungary

Table of Contents:

Antal Joó dr. – Gábor Joó: Possibility and Situation of Velomobile Riding in Hungary

Who is Who?

Antal Joó dr. (1957.) is a chemical engineer – economist. At present, he is the director of finances and investments at a chemical company. Bicycles, cycling, amateur bike building are his hobbies. For several years now, just for pleasure, he has been carrying out experiments, developing and using two- and three-wheeled recumbent bikes equipped with electric actuation. In 2008, his 20-year dream came true when he could take into daily use the first velomobile by which he has covered 4000 km-s up to now. During the Széchenyi Race[1] , which is a race of alternatively driven vehicles, in the hobby category he took 1st and 2nd position with the ANTIBRINGA H2 and ANTIBRINGA V vehicles in 2008 and 2009.

Antal Joó dr. engineer-economist
Petőfi u.9. H-8220 Balatonalmádi /HUNGARY
Tel.: +36(20)9652000
antibringa@freemail.hu
www.antibringa.hu

Gábor Joó (1986.) is an undergraduate in economics. He rather uses than builds bikes. If needed, he assists in building bikes and provides logistic support in case not every test is successful. He is a member of the ANTIBRINGA team and a winning competitor in the Széchenyi Race in the year 2009. He considerably contributed to the compilation and preparation of the presentation.

Gábor Joó undergraduate in economics
Damjanich u. 30. H-8220 Balatonalmádi /HUNGARY
Tel: +36(30)4336812
joo.gabor.1986@gmail.com

1. Introduction

Originally I had in mind to write a presentation on the properties of the optimal velomobiles. However, the organisers motivated me to deliver a lecture on the situation and possibilities of velomobile riding in Hungary instead. I express my thanks for it. However, it should be mentioned, as you will soon be convinced of that, velomobile riding is still at an early stage in Hungary.

That is the reason why so much is said of cycling. Velomobile riding has little chances till the cycling in Hungary reaches a critical mass. I think the highly developed condition of the bike transportation is closely connected with the

[1] http://szechenyifutam.hu, 2009-06-14

velomobile use. It is no mere chance that most velomobiles are manufactured and used in the Netherlands. It is the country where there are most bikes per capita and the proportion of cycling is the largest in the transportation.

In this presentation, you will find several critical remarks on the situation in Hungary. I would like to underline that the criticism is for the sake of cycling and not against something or some people. I am optimistic that cycling and velomobile riding will some day be so considerable in the transportation of Hungary as is now the case in Denmark, Netherlands or Germany. The changes in the world will force us to do so if our discretion and wisdom should prove to be insufficient.

2. The First Hungarian Velomobile

When having a quick look in the materials of the previous conference, I saw that most of the presenters had already been using velomobiles when I, about 20 years ago, saw the rough sketches of a recumbent and velomobile in a book on bicycles. It was love at first sight, and I hoped that some day I would get into some of them or maybe I would possess such a machine. Well, about three years ago, I took possession of my first home-made recumbent (ANTIBRINGA K serial), then a factory-made AZUB-5 and afterwards there followed a new home-made trike (ANTIBRINGA H serial). However, the top is the velomobile which I have been using since August 2008. This is not only my first velomobile but this is also the first factory-made velomobile in Hungary. After the joyful three weeks' assembling (BION X, disc brake, forced ventilation, windscreen etc.) I took the machine into everyday use. Since then, rain or shine, I have been going to work by it. Up to now, there have not been such extreme weather conditions which could have prevented me from using it.

1st picture ANTIBRINGA K7

2nd picture AZUB 5

3rd picture ANTIBRINGA H2 4th picture ANTIBRINGA V

Source: www.antibringa.hu ; www.szechenyifutam.hu Photo: Földi D. Attila

3. Nothing or the Lion's Share

Many of you may know the story when a shoe factory sends two market researchers to Afrika. In the market research study it reads: According to the pessimist: „everybody goes barefoot, therefore not even a pair of shoes can be sold". According to the optimist: „everybody is barefooted, therefore lots of shoes can be sold here".

In Hungary, the situation of velomobile riding is just the same. To the best of my knowledge, in Hungary, the territory of which has 93.000 square kilometres and there are 10 million inhabitants, there can be found altogether two velomobiles (a home-made one[2] and a factory-made one[3]). The imaginary pessimist sales clerk would write in his report that in Hungary everybody goes by car so not a single velomobile can be sold. I may as well finish my presentation at this point, but I am an optimist so I am continuing it. It can be clearly seen that even if the number of velomobiles is increased only by one, then it is a fifty percent growth. What dynamics! ☺

[2] http://ambringa.hu/kepek/galeries/Velomobil3_020._I.JPG , 2009-06-14
[3] http://www.antibringa.hu/?aerorider-leiba,25 , 2009-06-14

Area	93 000	km2
Population	10	million
Car	3	million
Bike	3,5	million
Recumbent	250	pieces
Velomobile	2	pieces
GDP	18 754	USD/capita
Motorway	1 113	km
Bicycle road	2 000	km

5th picture VELOMOBILES of HUNGARY

Source: Google map, www.ambringa.hu, www.antibringa.hu , KSH

4. Consciously and yet by Chance

I spent much time to select the best and ideal velomobile. For several months I corresponded with manufacturers. I had strict demands, from the size of the rear-wheel through to the springing to the colour and other parameters. At last I made my choice, ordered, paid a sum in advance and impatiently waited for the D-day. In the meantime, the type and delivery date were changed. Roughly about ten days before the deadline it turned out that the machine had not been manufactured with the ordered parameters. After some hesitation I cancelled the order but I took it very much to my heart. A year passed and I was forced to start from the beginning again. I said to myself: now I pick up the phone and make calls to manufacturers till I find someone who tells me that he has a velomobile to be sold and it can be promptly delivered. It was perhaps my third call when I spoke to a manufacturer who was willing to sell a test machine. We agreed. Within a week, the first factory-made velomobile was already travelling on the hood of my car to Hungary. The date was August 7, 2008. It is a most memorable day for me. I was consciously preparing for it, however, it was by blind chance that decided the velomobile type.

5. Velomobiles in the World

While purchasing my own velomobile, I made a lot of acquaintances. On my homepage, I was keeping informed those interested in Hungary about the recumbent bikes and velomobiles. I was deeply involved in the question what is the ideal velomobile like. I was curious to know how many types of velomobiles there are and how many people use velomobiles in the world. I was reading the homepages of manufacturers, where I could collect information about the abundance of the types as well as their technical data. However, I could hardly find any data about the number of velomobiles. While I was already collecting material for this presentation, I hit upon the idea of asking the manufacturers. Nothing ventured, nothing gained. On the Internet I was searching for all velomobile manufacturers (I succeeded in this up to perhaps 90 percent), and international organizations for bicycles, who could provide me with data. I turned to them in e-mails and I have met some of them.

It was a great pleasure to me that almost everybody responded to me. There were several people who gave me estimated data, but in any case, they were very helpful in sharing their data with me, without any limitation to publish. I sent out 49 questionnaries, and I received back 45 with any kind of feedback. The contents and quality of the replies were ranging from „unfortunately I have no time" through to the detailed and substantial information. I am happy to tell you that the latter ones were in decisive majority.

I am greatly indebted to the following persons, by the help of the information, advice and homepages of whom I could prepare this chapter: *Andreas Fuchs, Andreas Pooch, Bart de Wert, Bob Stuart, Brian Sauer, Brecht Vandeputte, Carl Georg Rasmussen, Craig Johnsen, Christian Wagner, David M. Eggleston, Dana Lieberman, Dietrich Lohmeyer, Elmar Maier, Gavin Keats, German Eslava, Jack Dekker, Harry Lieben, Johan Vrielink, John Olson, Jürg Birkenstock, Mary Arneson, Marcus von der Wehl, Matthias Erz, Michael Beyss, Mick Sims, Neil Sellwood, Peter Eland, Peter Zoomers, Ray Mickevicius, Rod Miner, Steve Schleicher, Thomas Breedlove*, *Thomas Seide, Vasili Gess,Ymte Sijbrandij, Yvan Dutil.*
For any mistake, only the authors of this presentation are to blame. Your corrections and proposals are welcome.

6. Before you Resume Reading...

Before you resume reading this chapter, I request you to answer the questions below and give some estimates, resp. That is requested because in this way you will be in the position to compare your ideas with the estimates of others as well as the facts.

1.) How many velomobiles are there in use in the world currently, and how many of them can be found in Europe, in the USA and Australia?
2.) How many velomobiles altogether have been manufactured in the world up to now, and how many of them were manufactured in Europe, in the USA and Australia?
3.) How many velomobiles were manufactured in the world, in Europe, in the USA and in Australia in the year 2008?

Now, if you have the estimates ready, let us see the estimated data and the facts.

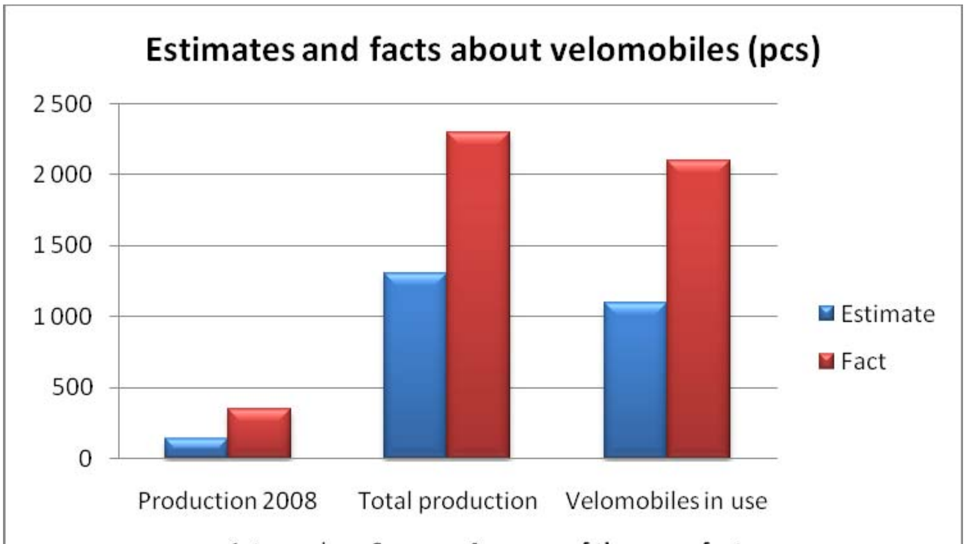
7. Estimates on the Number of Velomobiles

Several people tried to estimate the number of velomobiles. Of them, the data of Mr Peter Eland (Velo Vision) should be emphasized. Among the respondents, he is remarkable for trying to give estimates for nearly all types, and in several cases they are very close to the facts. Let us see now the estimates of the respondents concerning the above mentioned questions:

1.) In their opinion, in the world there are now roughly 1000-1200 velomobiles in use. Of them, there are 900-1000 in Europe, 50-100 in the USA and 10 in Australia.
2.) They estimate that altogether about 1200-1400 velomobiles have been manufactured in the world up to now. Of these quantities, 1000-1200 are thought to have been manufactured in Europe, 30-100 in the USA and 10-100 in Australia.
3.) They estimate the velomobile manufacture of the world was in the range of 120-160 pcs in the year 2008, of which 100-150 were made in Europe, 5-10 in the USA and 2-10 in Australia.

8. Facts on the Number of Velomobiles

Comparing the facts of the manufacturers with the estimates, we can say that even the most optimistic estimates place the number of the currently used velomobiles and the velomobiles manufactured altogether and manufactured last year scarcely at the half.



1st graph **Source: Answers of the manufacturers**

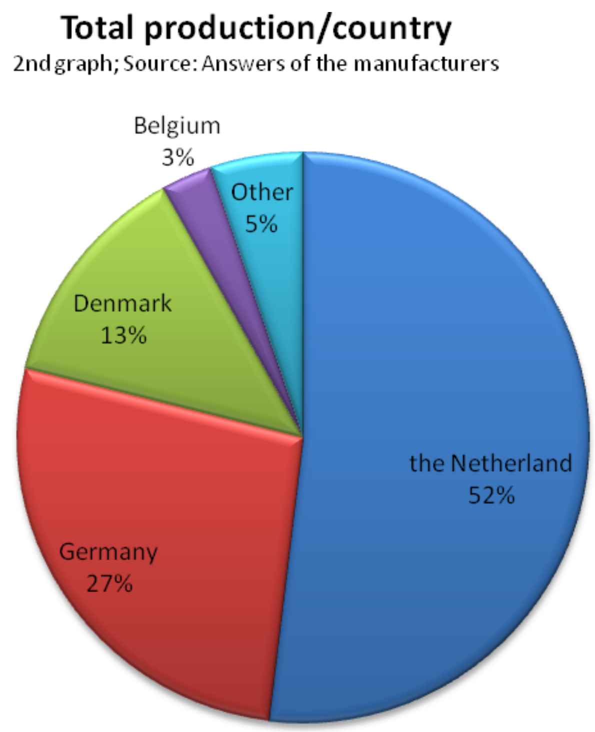
Let me note however, that there are estimates in some cases among the facts as well because the manufacturers of some types could not be found, or, some people did not give any data or they gave only some details. This is marked in the appendices separately in every case. My estimates are intentionally underestimated. The so-called „other velomobiles" category contains the velomobile manufacturings which are unpublished. However, it is evident that there are several individual attempts in the world. These I estimated from the beginnings (from 1983 on) to be altogether 60, and 19 in the 2008 year's manufacture. To be sure, unique velomobiles were manufactured more than that. For example, one was made in Hungary too. Detailed information were received from European, American and Canadian manufacturers and users. Some data are also available from Australia.

Velomobiles are not manufactured to be on stock therefore we can say what had been manufactured it was put into operation somewhere. That is why there is no significant difference between the data of manufacture, sale and putting into use. Several manufacturers are of the opinion that of the total manufacturings, there can be maximum 200 velomobiles (in the range of 5-10 percent) which are out of use today.

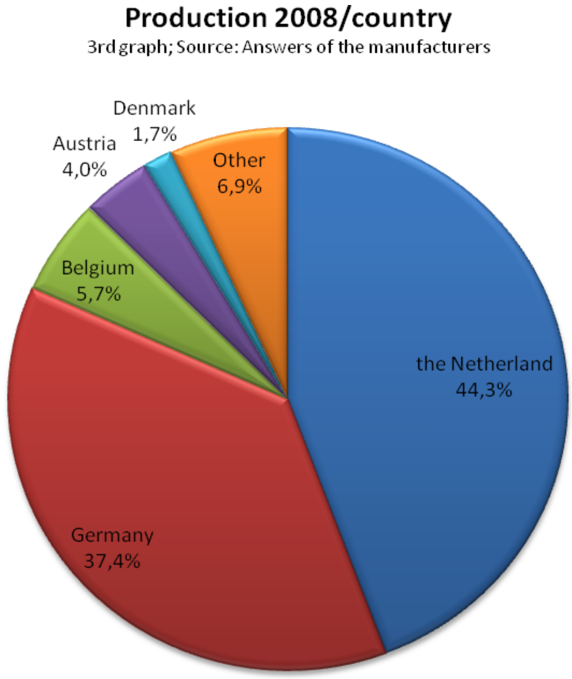
After these preliminary remarks, it can be said that till March 31, 2009 (the closing date of the data collection) the total number of the manufactured velomobiles in the world amounted to 2300, of which 350 were manufactured in 2008.

The number of the velomobiles being in use is by approximately 200 pcs less than that. It means there can be about 2100 pcs in the world. The decisive majority of the indicated quantities are manufactured and used in Europe. The manufacture in the USA, Canada and in Australia does not exceed 30 pcs, on the other hand, the number of the velomobiles used in these countries can be in the range of 90-100 pcs.

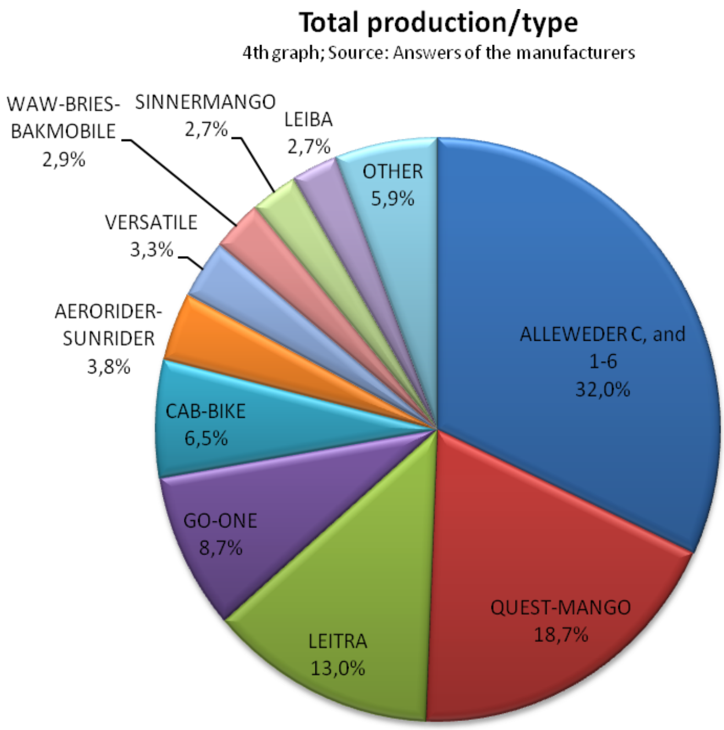
Regarding all manufacturings up to now, the order of the manufacturing countries is as follows:



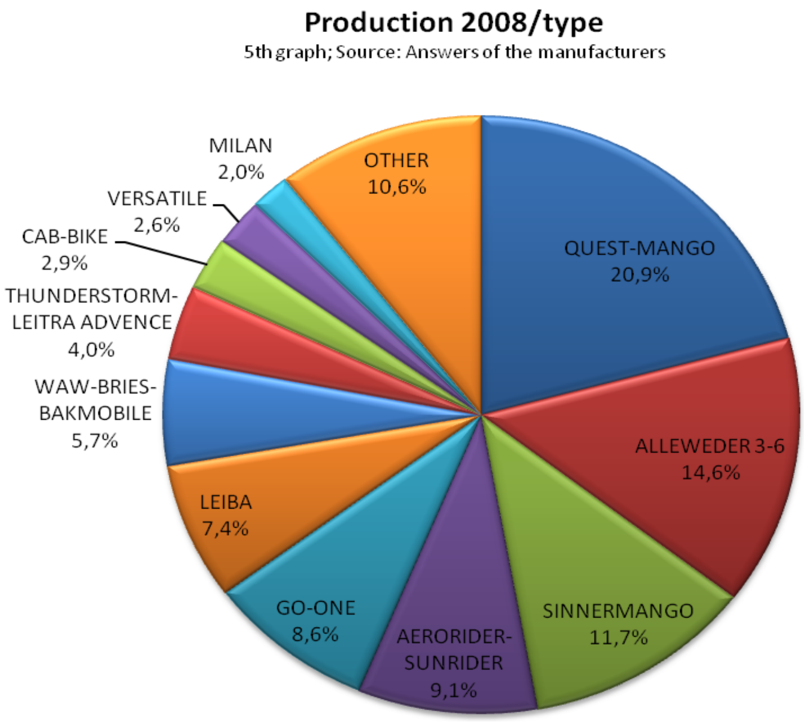
However, if we examine the manufacture in the year 2008, then the proportions will change as follows:



Regarding velomobiles manufactured up to now, the order of the various velomobile types (the same types and manufacturers collected into one group) is the following:



If we examine the manufacture in the year 2008, then the order will be as follows:

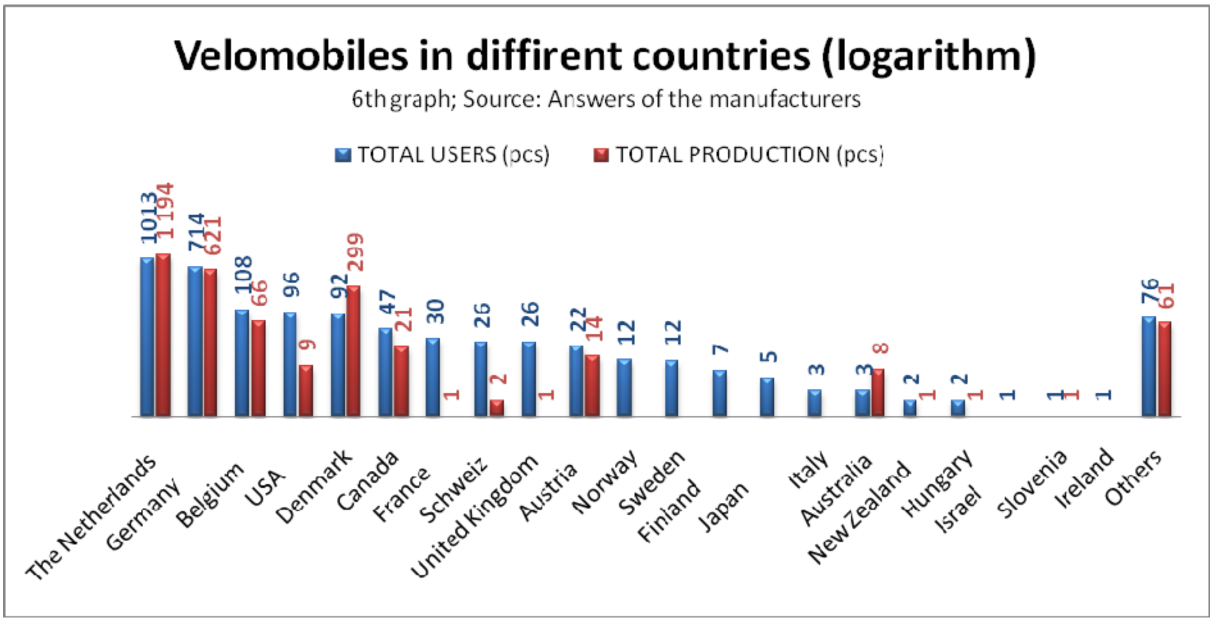


There are no detailed data to demonstrate the annual growth of the manufacture. However, the starting point can be the analysis of Yvan Dutil[4] prepared in 2006. According to the author, the number of sold velomobiles amounted to 59 in 2000, and to 166 in 2006, which is an annual 16 percent growth. If we accept these figures, it can be seen that between the years 2006 and 2008, the sales (manufactures) increased to more than twofold (350 pcs).

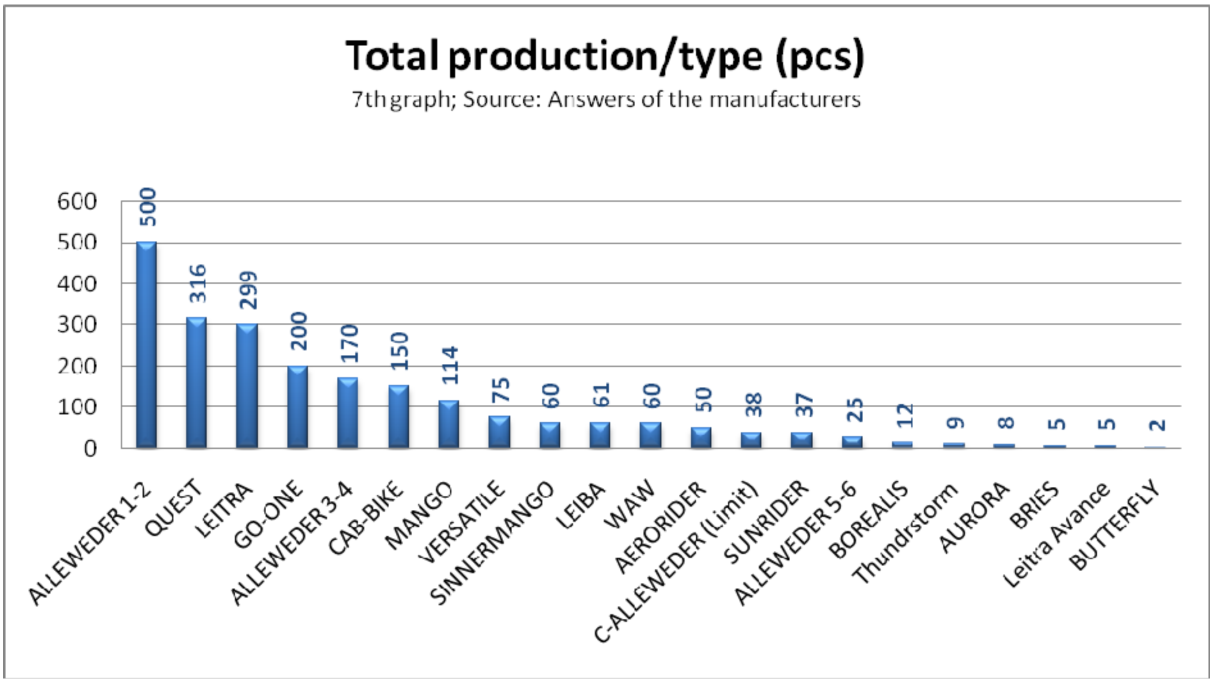
It is interesting to note that, although Alleweder 1-2 type was very successful as KIT (500 pcs were made, and the price was most reasonable), no manufacturer offers such a solution nowadays.

The split-up order of countries using velomobiles is very similar to the order of manufacturing countries. It means that most velomobiles are manufactured and used in the Netherlands and Germany. It can be seen in the following graph that the total manufacture exceeded the total use only in the Netherlands and Denmark. At the same time, in the year 2008, Holland was the sole net velomobile exporting country. Eighty percent of velomobile manufacture and use concentrate in three countries (Holland, Germany and Belgium).

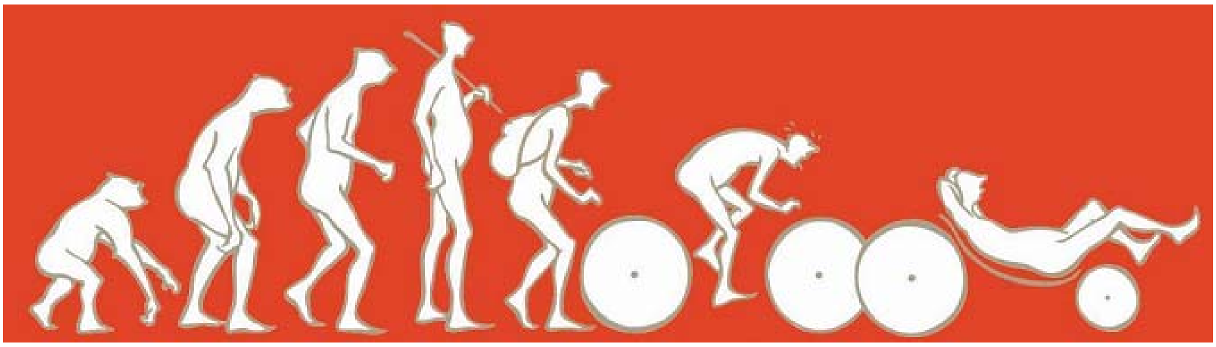
[4] Yvan Dutil, [2006]: pp. 1



Among the manufactured velomobile types, Alleweder 1-2 is still leading (500 pcs), though it has not been manufactured for ten years. Quest, being in the second place, continues to be very popular (316 pcs). It was from that type that the most was produced in 2008. Regarding the total manufactured quantity, Leitra is in the third place (299 pcs). Manufacture in Denmark is in decline, it is now manufactured in Austria under the tradenames Leitra Avance and Thunderstorm. It is noteworthy that the youngest Leitra owner is 13 years old, while the oldest one is 94 years old. Nine types make out 80 percent of the total velomobile manufactures. Manufactures of Quest, Sinnermango, Alleweder, Leiba and Aerorider-Sunrider are increasing.



9. A Bit of History

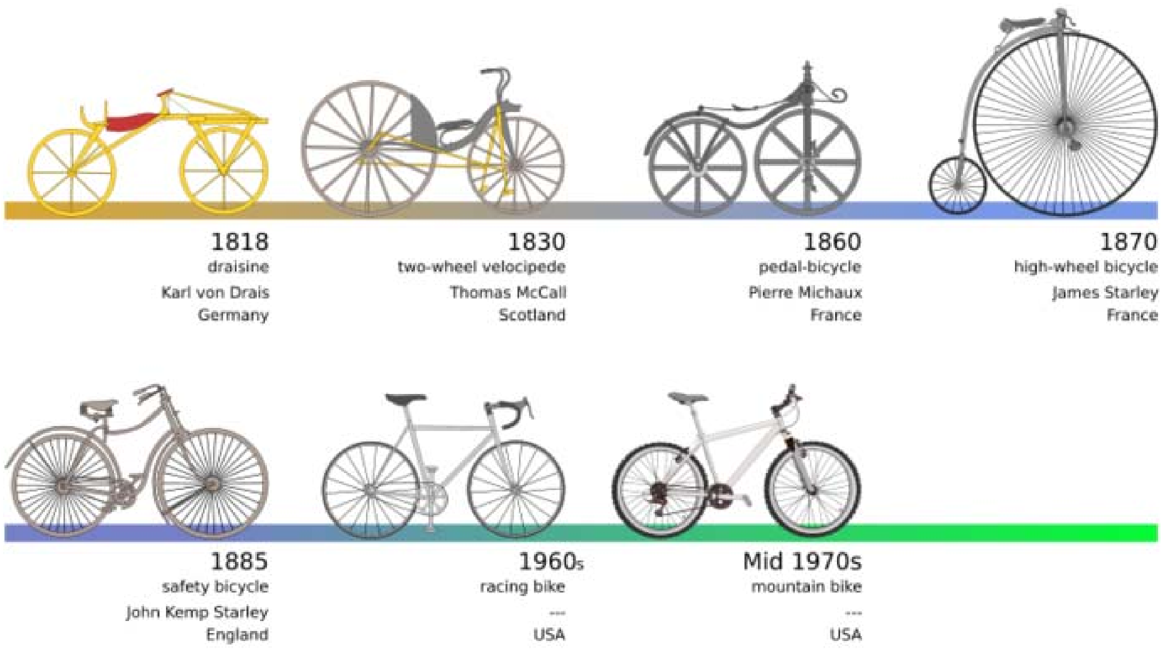


6th picture Bicycle evolution 1.

Source: www.ambringa.hu

According to a study made in 2006, in Holland [5] the bicycle went through the following epochs:

1. luxury article (till 1900)
2. from luxury article, an everyday vehicle (1900-1920)
3. the bicycle as a necessary commodity (1920-1950)
4. being a subordinated vehicle, driven in the background (1950-1970)
5. an everyday vehicle (1970-
6. The above epochs can be complemented by the appearance of recumbent bikes and velomobiles. They are missing from the following picture:



7th picture Bicycle evolution 2

Source: http://wapedia.mobi/commons/File:Bicycle_evolution-en.svg

[5] http://www.khem.gov.hu/data/cms1168940/kerparoskozlekedes.pdf ,2009-06-17

The first golden age of velomobiles starts from the 1920', and the second one from the 1980' years. [6] Main dates and types, complemented with some man-powered aquatic and air vehicle records:

1924 VELOCAR (Charles and Georges Mochet, France, four-wheeled, in about 15-18 years, more than one thousand pcs were manufactured (according to other sources, 6000 pcs were manufactured)

1930? PILOT MCB 101 (Ulf Cronberg, The Swedish velomobile "Pilot" was sold as drawings and do-it-yourself guide. Not very many were actually built.)

1940 FANTOM, (Hobbex, Sweden, three-wheeled, in 40 years 30 000 pcs were manufactured (according to other sources, 100 000 pcs)[7]

1948 FEND FLITZER (Fritz Fend, Germany, three-wheeled, which later transforms into a vehicle without pedal)

1949 AMPHIBIKE (Reino Karpio & Matti Naranen, an amphibian velomobile, which crossed the open sea between Helsinki and Stockholm)

1979 CYCLODYNE (Alan Carpenter, USA, Colorado, up to 1982, 14 pcs were manufactured)[8]

1979 LEITRA (Carl George Rasmussen, Denmark, three-wheeled, up to now 299 pcs were manufactured, the sale began in 1985)

1980 WINDCHEETAH (Mike Burrows, Great-Britain, a few pieces were made)

1983 SINCLAIR C5 (Sinclair Vehicles Ltd, England, three-wheeled, with pedal and 250 W electric motor)

1983 VELERIQUE (Belgium, it was a fashionable and nice but a dangerous two-wheeled model, and the manufacturer went bankrupt in a few years)

1985 ALLEWEDER (Bart Werhees, Holland, a three-wheeled velomobile, aluminium framework and cover, it was sold as a KIT for assembling between 1993-99, 500 pcs were manufactured)

1988 DECAVITATOR (Prof. Mark Drela, a man-powered boat, it reached a 34,3 km/h average speed record in a 100-meter race)

1989 DESIRA (two-, three- and four-wheeled, there were six kinds of models, the last one was manufactured in 1999)[9]

1991 GO-ONE (Michael Goretzky, Michael and Andreas Beyss, Germany, a stream-lined, three-wheeled velomobile with plastic cover, to this day 200 pcs were manufactured)

1993 FIRST VELOMOBIL SEMINAR (Copenhagen)

1995 AEOLOS (two-wheeled, closed velomobile, which covered more than 80 000 kilometres between 1995-2004)

1996 CAB-BIKE (German Eslava - Reinhold Schwemmer, Germany, a three-wheeled velomobile, up to now 150 pcs were manufactured)[10]

1997 C-ALLEWEDER (LIMIT) (Gerrit Tempelman, Aller Jacobs, Ymte Sijbrandíj, Holland, 3-wheeled, the first one-bodied composite velomobile, between 1997-2002, 40 pcs were manufactured)

1998 DAEDALUS 88 (Kanellos Kannellopoulos, Greece, man-powered aeroplane, which flew across the 130-km distance between Crete and Santorini in 3 hours 54 minutes)

---

[6] Carl-George Rasmussen-Jöürgen Eick: Survival of the fittest, 5th European Velomobile Seminar, Germersheim, 2004.
[7] Frederick Van De Walle: The Velomobile as a Vehicle for More Sustainable Transportation
[8] Ingo Kollibay: Cyclodyne –the forgotten velomobile, 5th European Velomobile Seminar, Germersheim, 2004.
[9] Stefan Gloger: Desira-Story, 5th European Velomobile Seminar, Germersheim, 2004.
[10] German Eslava-Reinhold Schwemmer: Cab-Bike Velomobile on a based Modular Concept, 5th European Velomobile Seminar, Germersheim, 2004.

2000 QUEST (Ymte Sijbrandij, Holland, 3-wheeled velomobile, glass fibre reinforced plastic cover, from 2005 on with a 26"-wheel in the back, up to now 316 pcs were made)
2002 MANGO (Gerrit Tempelman, Holland, 3-wheeled, 14 pcs were made up to 2007, now it is manufactured under the name SINNERMANGO, of which 62 pcs were manufactured till now)
2002 VARNA DIABLO (Sam Whittingham, Canada, in the Battle Mountain, USA Nevada, the top speed at 200-m flying start was 130,33 km/h)
2002 WHITEHAWK (Lars Teutenberg, in the testing centre of Opel, Germany, Dudenhofen, from standing start the 1-hour average speed top was 82.601 km/h)
2002 WAW (Brecht Vandeputte, Holland, a 3-wheeled velomobile with module system, 60 pcs have been manufactured)
2003 VERSATILE (Johan Vrielink, Holland, 3-wheeled velomobile, computer-aided design, environmentally-friendly, thermoplastic PP was used in the cover, 75 pcs have been manufactured)
2004? AERORIDER (Bart de Wert, Holland, a 3-wheeled velomobile with electric actuation, the windscreen is made of glass, an especially nice design, from 2008 the AERORIDER SPORT type has been manufactured which is a SUNRIDER equipped with electric actuation. Up to now 53 (50+3) pcs were manufactured.
2004? SUNRIDER (Bart de Wert, Holland, a three-wheeled, streamlined velomobile of high demands, up to now 34 pcs were manufactured)
2006 LEIBA (Vasili Gess, Germany, a 3-wheeled velomobile, its types are: Classic, Brise, X-stream, 61 pcs have been manufactured)
2008 VELAYO (Marcus von der Wehl, Germany, a 3-wheeled velomobile, three pcs have been manufactured)
2008 GLYDE (Ian Sims, Australia, a three-wheeled velomobile)
2009 GO-ONE Evolution (Michael and Andreas Beyss, Germany, a 3-wheeled velomobile, in contrast to the previous model, the rear wheel was also put under the cover)

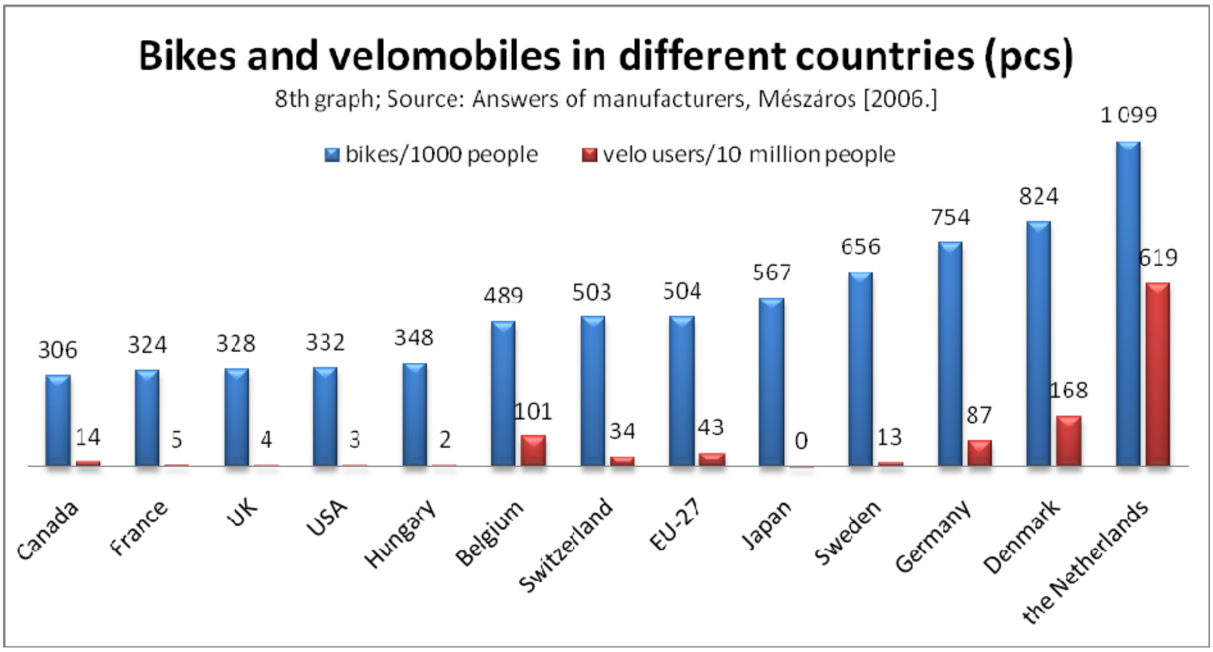
Based on all these, it can be stated that the flourishing velomobile manufacture in the first half of the past century (with its order of several ten thousands) considerably surpassed the hoped-for second golden age which began in the '80-ies of the past century (2300 pcs).

10. How is it Going on in the World?

Generally it can be said that in the developed world, bicycle riding is more and more spreading. On the other hand, unfortunately, in the developing countries opposite tendencies can be observed. To demonstrate this, I compiled some data from various parts of the world.

Approximately 1.6 billion bicycles can be found in the world today. The split is: there are 500 million in China, 250 million in Europe and 150 million in the US. The largest bicycle manufacturers of the world are China and India. In 2005, 80 million of bicycles were manufactured in China, which amounts to about 60 percent of the world production. The share of India was 11 percent.

The number of bicycles per 1000 inhabitants and that of velomobiles per 10 million inhabitants in various countries are demonstrated in the following graph. As far as the first three countries are concerned (Holland, Denmark and Germany), we can say that the number of bicycles correlate with the number of velomobiles.



In Europe, the proportion of those using regularly bicycles for transportation, amounts to 20-25 percent.[11]

Holland is the country where everybody cycles. There is no other country in the world where there are more bicycles than inhabitants. The population of Holland is 16.5 million, while 18 million of bicycles are registered. On a yearly basis, 1.4 million of new bikes are sold, and, if we presume that they not only buy the bicycles but also use them, in this case they pedal 900 km-s per capita yearly.[12]

In the Western towns of Germany, bike riding rose by 50 percent between 1972 and 1995. This results from the authority measures which also considered public interest. These measures included the building of cycle lane networks and bike tracks, making the traffic more favourable, teaching school-children the traffic rules, frequent inspections by the police so as to prevent thefts, establishing bicycle storing and renting facilities etc. Munster is an outstanding city from this point of view where 32 percent of the roads are covered by bikes in spite of the fact that, on an average, on 238 days of the year it is raining. It is true that as early as 1995, there existed a 252-km long cycle lane network and further 300 km-s public road could be used by bikers. In Germany, the cycle lanes are longer than 40 000 km-s.

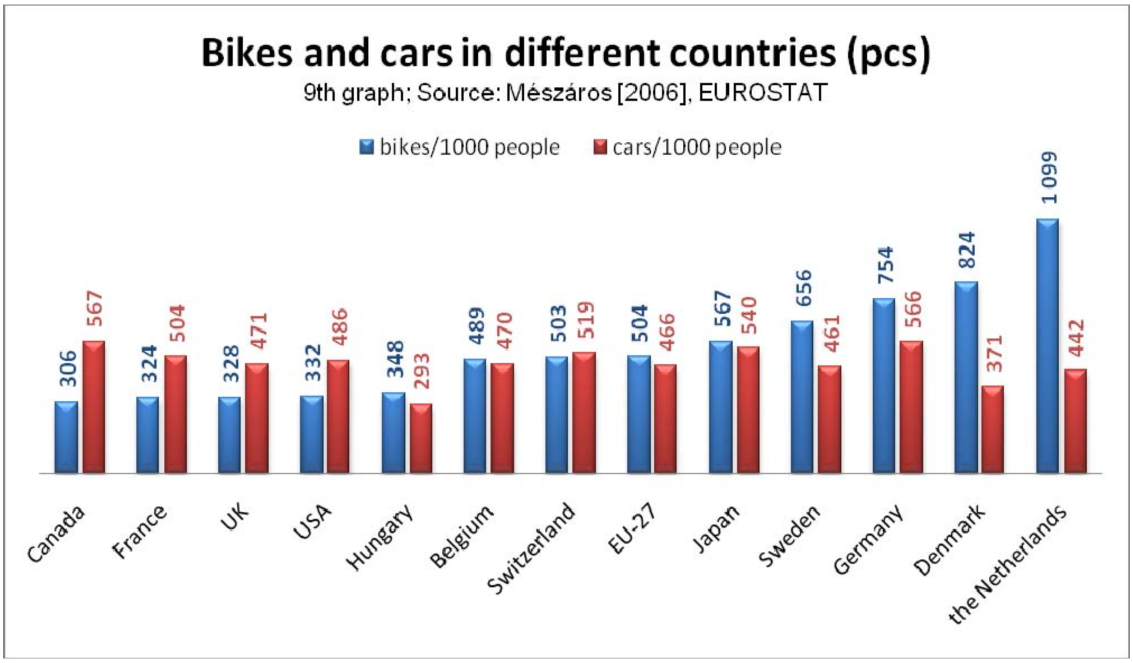
In Europe, the proportion of town roads is the smallest in France and Italy (5 percent), and the highest in Holland (30 percent). In the cities of the US, this amounts to only 1 percent.[13]

[11] http://bikemag.hu/kiemelt/varosban-biciklivel , 2009-06-13
[12] http://criticalmass.hu/blogbejegyzes/20081029/valsag-kerekpar, 2009-06-13
[13] http://www.harmonet.hu/cikk.php?rovat=258&alrovat=266&cikkid=278, 2009-06-13

In Copenhagen, 3000 bikes are provided free-of-charge to cover short distances. No wonder that one-third of those going to work go by bikes. High parking fees and usable cycle lanes account for the fact that, e.g. in Amsterdam, 35 percent of local traffic is made by bikes. In Great Britain, a plan was made on how the bike use can be increased fourfold by the year 2012.[14]

In Brussels, you can cycle in each one-way street in both directions. There is a moved-forward bike stand at every traffic light. The level of every road junction is raised so as to reduce speed, and there is cycle lane, recommended lane or bike track on every road of large transportation. All that have been established in the city in the past 3-5 years, which had formerly been designed exclusively for traffic by cars. However, they were determined to make the city „cycleable" again. [15]

In the following graph, the number of bikes and cars per one thousand inhabitants can be seen. The same countries are leading which are prominent in the bike riding and velomobile riding as well.



In China, about 450 million (with an accuracy of ± 50 million) of bikes are registered. The number of electric bikes is dynamically increasing. In 2006, 16-18 million pcs were sold, while the sales in the US and in Europe amounted to only 100-100 thousand pcs. In several cities of China the motorbikes and scooters were banned. That facilitates the use of electric bikes and scooters, though it is true that the lead batteries and the current made of fossil power also result in environmental problems.[16]

[14] http://www.fenntarthatofejloves.net/2007/03/25/kerekparutak-itthon/ , 2009-06-13
[15] http://www.kerekparosklub.org/meghivo-a-velo-city-konferencia-beszamolojara ,2009-06-20
[16] http://www.zoldtech.hu/cikkek/20070709elektromoskerekpar , 2009-06-13

Unfortunately, opposite trends have also started. In China and India, virtue might have been made of necessity, if, parallel with the economic growth, the transportation by railways and bikes would have been preferred instead of cars. The use of bikes is decreasing in China and India. Sixty percent of those going to work used bikes in Beijing in 1998. Today, this proportion is only beneath 20 percent. Several cycle lanes in Beijing were transformed for use by cars. In India, the travels by bikes make out about 15-30 percent. Bike riding is popular mainly in the agricultural regions. However, it is a disadvantage that there is shortage of safe cycle lanes and parking facilities.[17] If the Chinese motorization approaches the level of developed countries, then it is feared that considerable regions and arable lands will be sacrificed (road building, parking) , which can even result in food shortage.

11. And How is it Made in Hungary?

The present situation of bike and velomobile riding is not bright in Hungary, however, the outlooks are promising. We still have to fight the struggle that had been successfully won by Denmark, Holland or Germany several decades before. I am greatly impressed and, in the good sense of the word, I envy these countries, where the various transportation means could be integrated in an efficient way. The various transportation means get on well side by side. There are excellent motorways in these countries, air transport and railways are organized well, but there are cycle lanes everywhere as well. There are parking lots at the railway stations and covered cycle storing facilities, smoothly accessible ramps leading to the railway carriages etc.

Referring back to the epochs of the bicycle in the previous chapter, Hungary may now enter the era reminiscent of Holland in the 1970's, when step by step, the bike becomes an everyday means of transport. That holds good by all means for Budapest, the capital, but the bike use is again increasing in the country as well.

Let us see some data on the Hungarian situation. In Hungary, about 3.5 million of bikes are registered, the number of cars amount to 3 million. At present, the length of the Hungarian public road network is: 30.000[18]-[19] km-s public road,and 1.113[20] km-s motorways and freeways.[21] The length of the cycle lanes is about 2000 km-s (according to other sources, 2367[22] km-s). A considerable part thereof does not meet the demands of bikers, thus, the real length of the cycle lanes does not reach even 1.500[23] km-s. The contradiction of the data gets some message across to us,

[17] http://www.fenntarthatofejloves.net/2007/03/25/kerekparutak-itthon/ ,2009-06-13

[18] http://www.kkk.gov.hu , 2009-06-14

[19] According to the Magyar Közút Nonprofit Zrt. (Hungarian Road Nonprofit Co.): „The length of roads is 31 240 km-s. About 75 percent of the country's total road traffic runs on this road network. Of that, 7 958 km-s are motorways, including 2 204 km-s "E" road, i.e. part of the European road network. 28 percent of that cross settlements, it means they play an important role in the local traffic of settlements. This road network is managed by Magyar Közút Zrt. Length of the roads managed by the municipalities amount to 140 000 km-s."
http://internet.kozut.hu/szakmai/orszagos_kozutak_adatai/kozutakfojellemzoi/Lapok/default.aspx , 2009-06-14

[20] http://hu.wikipedia.org/wiki/Magyarorsz%C3%A1g_aut%C3%B3p%C3%A1ly%C3%A1i , 2009-06-14

[21] According to Magyar Közút Nonprofit Zrt.: „Length of the freeways network (motorways, public roads) is 1055 km-s, the motorways with intersections are 373 km-s."

[22] http://www.antibringa.hu/?bringa-szamtan,18, 7. article, Bodor Ádám , 2009-06-14

[23] Real length of the cycle lanes cannot be defined exactly. Various sources provide with contradictory data. According to the table downloaded from the website of Magyar Közút Nonprofit Zrt. on Febr 8, 2009, length of the cycle lanes is 1637.3 km-s. This table is not accessible on the website at present.

because it is expected from the competent authorities that they should know and let us know what is what and how many. If we compare the data with those of Germany, it can be seen that in Germany the cycle lanes (40 000 km-s) are longer than the whole public roads in Hungary (30 000 km-s).

Sorry to say, the modest quantitative index is associated with several quality defects. The small number of cycle lanes are often built in bad quality. When building them, presumably the regulations were not observed which are taken into consideration stricter when building public roads (taking off the top soil, observing the layers order, compression, quality and thickness of wearing layer etc.). When the vehicle traffic starts on a public road, these defects will soon become evident. In case of cycle lanes, they will appear only years after. It can be clearly seen that, in contrast to the public road, people using the cycle lanes cannot damage them. The condition of cycle lanes depends primarily on the level of the building and maintenance. [24]

Maintenance of the ready cycle lanes also leaves much to be desired. The road damages, cracks are not repaired in time, the roadsides are not mown, they are not tidied up etc. The owners (public road offices and municipalities) do not meet their obligations.

Most of the constructed cycle lanes are narrow (1.8 m). Regarding the width, they could be suitable even for velomobiles, but the real useful width is not more than 1.4-1.6 meters because the roads and roadsides are not maintained properly.

You can find bike storing facilities near the railway stations only now and then. Elimination of obstacles is almost unknown at the railways. The railway stations and the carriages are not constructed in such a way that bikes could be pushed in or on easily. Of course, it is also a problem that the railway network, the planning, speed of the trains and accuracy fall behind to that of you are accustomed to in the West.

Much should be done also for improving the level of traffic culture. Impatient car drivers and bikers, violating all regulations, cause a lot of nuisance and accidents. It is no mere chance that the number of cars per 1000 inhabitants in Hungary is only about the half of that of Germany (293 in Hungary and 566 in Germany), however, the death toll of traffic accidents ist just the double (122, and 60 persons/year/million inhabitants, resp.), that is, the Hungarian index is four-fold worse.

It is considered to be forgivable sins to drive by cars, motorbikes and scooters on the cycle lanes, and so is parking on the pavement and cycle lanes. On the other hand, bikers are often signalled by the car drivers to keep off the public road, and it often happens that it is a policeman who drives away the bikers from the road to use the otherwise unusable, unpassable „cycle lane” instead.

Motor vehicles are preferred exaggeratedly to bikers. The pace of public road construction, motorway construction and renewal manifold surpasses the pace of

[24] http://www.nol.hu/archivum/archiv-461960 „According to a survey made by the Balatoni Szövetség (Association of Lake Balaton), which organization coordinates the municipalities situated at the lake, the condition of roads is damaged by bumpy sections due to tree roots as well as by weeds growing from beneath the asphalt and potholes. It is stated in this survey that the premature wearing off of the cycle lanes is not caused by the heavy traffic but primarily by the undemanding building in quick campaigns and by negligence.”

cycle lane construction and renewal. Bikers are more and more driven out of the formerly small-traffic public roads due to the enormous heavy traffic. As a consequence, cycle traffic among the various settlements has drastically decreased in the past years.

Traffic by bicycles is a marginal element in the decisions and attitude of authorities who participate in the forming of the transportation infrastructure and traffic organization. There exists no ability to enforce the interests of bikers in merit. Authority people make decisions who are committed to motorization, and they do not use in work bicycles or do so only occasionally.

Motor vehicles are in a more favourable position not only for their strength but also regarding the traffic rules. Traffic organization is not unified even in the same situations, e.g. regarding the right-of-way at the junction of public roads and cycle lanes, which vary in every settlement.

To summarize, there are only a few cycle lanes in Hungary, and a part of them is in bad condition. Biking is not or not properly supported by either the traffic rules or by the competent decision-makers. The traffic culture also leaves much to be desired.

12. Something has Started

As late as the recent past, cycle lanes in Hungary were not connected into a contiguous network, and their technical level fell far behind the European norms. A cycle lane network development programme, which covers the whole country, is dedicated to remedy this problem. This programme will be realized within the framework of the New Hungary Development Plan. The official justification of the inviting of applications regarding bikers, reads: „Traffic jams, parking difficulties and air pollution are the most characteristic problems of cities. In the member countries of the European Union, and in Hungary as well, it is a governmental goal to popularize the biking because that means an evident solution to reduce the environmental impacts and to remedy the everyday traffic nuisances.” [25]

According to the governmental plan entitled „Biker Hungary Programme 2007-2013”, from the budget more than HUF 60 billion (€ 214 million) will be allocated for this purpose till 2013. By rational and harmonized developments, by the year 2013 roughly 2000 km-s of new cycle lanes and tracks can be built, and, in addition to the proportional growth of the bicycle traffic, the number of deadly accidents of bikers can be reduced to half, and even 5 percent of the European bicycle tourism market can be obtained. The first main elements of the programme are the infrastructure building and maintenance. The second one is the cultural development of the bike traffic, e.g. by the help of training programmes, by modifying the Highway Code, by frequent inspections and the restructuring of the Hungarian Railways Co. into a bike-friendly company. The third element is the development of bike riding for tourism, sport and recreational purposes, primarily by joining EuroVelo, the European cycle lane network. [26]

[25] http://bikemag.hu/kiemelt/varosban-biciklivel , 2009-06-13
[26] http://www.fenntarthatofejloves.net/2007/03/25/kerekparutak-itthon/ , 2009. június 13.

EuroVelo, the full name of which is **European Cycle Lane Network,** is a plan of the European Bikers' Association for establishing 12 cycle lanes crossing all Europe. The total length of these lanes is more than 60 000 km-s, of which more than 20 000 km-s have already been finished. The EuroVelo cycle lanes are designed for biker tours crossing the Continent, by connecting them with the existing ones. Of course, it will be possible to use the EuroVelo routes in the local bike traffic as well. Two EuroVelo routes will cross Hungary, the one being **EV6**, running from the Atlantic to the Black Sea („Rivers Route, between Nantes—Constanca 3653 km-s, the Hungarian section thereof will cover 440 km-s). The second one will be **EV11**, running from Norway to Greece („Eastern European route", between the North Cap and Athens", covering 5964 km-s.)[27] Placarding of the section of EV6 in Hungary is in progress.

8th picture EUROVELO

Source: http://wapedia.mobi/hu/EuroVelo

[27] http://wapedia.mobi/hu/EuroVelo , 2009-06-13

The size and growth of the mass basis of Hungarian bike riding can best be illustrated by the development of the Critical Mass movement which started in the US. The purpose of the demonstration, which is held twice yearly, on the Earth Day and the Car-Free Day, is only partially to popularize environmentally-friendly means of transportation. Another goal is, through the demonstration of a mass basis, and by the intervention of civil organizations, to put pressure on the decision-makers in matters concerning bikers. The first organized demonstration took place in Budapest in September 2004, with 6000 participants. There were most participants present on the Critical Mass demonstration with 50 000 people in the capital, which took place on the Earth Day in April 2006. In the meantime, similar events were organized throughout the country. By that, the Budapest CM deserved the title of the greatest similar event in the world and it was recognized by the foreign civil bikers. In the meantime, the number of bikers increased manifold in Budapest in four years. (In the country, however, an opposite process can be observed.) Of course, the long-term goal would be that the present 1-2 percent ratio of regular bikers in Hungary approach the 20-25 percent European average.[28]

Positive signs can be seen in the traffic culture as well, especially in the circle where people not only drive cars but they often get on bikes as well.

An action called „Go by bike to work”, organized by the Hungarian Bikers’ Club, was finished this spring. That was the umpteenth successful action of this kind, calling the attention of more and more of people. Number of the teams, having 1-5 members, amounted to **5 896**, and the covered distances were altogether **4 248 242** km-s. The reduction of the carbondioxide emission was **790 173** kgs, and the fuel saving was HUF **89 213 078** (€ 318 618). The company I work for participated with 57 persons in the action, which means 35 percent of the staff. [29]

However, some exceptions can be observed in the mentality among the senior managers and bikers as well, e.g. Ms Júlia KIRÁLY, vice president of the Hungarian National Bank. Quote from the interview made with her: **Is it good manners for the vice president of the issuing bank to go by bike?** Ms Ibolya GÖRÖG was the protocol chief of the prevailing government for decades. One of her basic principles is that the vice president of the issuing bank is not allowed to go by bike to a conference, discussion, and not even to work. My counter-argument is my favourite photo. That was published on the cover page of Financial Times three years ago. The photo shows Mme Lagarde, the financial minister of France, getting on the bicycle and starting to work, while wearing a beautiful custom and stilettos. If she is allowed to do so, I think so is allowed the vice president of the issuing bank as well. **What are the arguments of the protocol expert against bike riding?** In her opinion, and she is right, the Hungarian society has respect of authority. If somebody is in a high position, then he or she must behave accordingly, otherwise the people will be confused. In this society, a general on bike is a most unusual phenomenon. [30]

As for the railways, you can deliver bicycles on an increasing number of trains, which facilitates the combined transportation means.

[28] http://bikemag.hu/kiemelt/varosban-biciklivel , 2009-06-13
[29] http://www.kamba.hu , 2009-06-14
[30] http://www.kamba.hu/index.php?option=com_content&view=category&layout=blog&id=34&Itemid=77, 2009-06-20

According to the new standard, the new cycle lanes are being built wider (minimum 2.6 metres), and the builders have to consider several technical regulations.[31] Thereby, it is to be hoped that the construction quality will be better.

To sum up, we can hope that in 4-5 years, the length of cycle lanes in Hungary will be doubled and reach 4 000 km-s. Perhaps the worn-out roads will also be renewed. Much depends on whether the government, the authorities and municipalities are willing to implement the excellent plans in the everyday practice.

13. VELOMOBIL and Bike Maths

Nowadays bicycles are used basically for two reasons: either because people are poor or because they are conscious. Most bicycles can be found in the very poor and very rich countries. „There are some people who can afford only bikes, and there are some people who can afford even bikes”. [32] Let us see some bike maths.

Distance: The automobile, which is the main cause of traffic chaos, the stress in cities and towns and the air pollution, has been one of the symbols of the recent past. Now it fell victim to its own success story. It is just the use of bikes that can be an „antispasmodic” in the road transportation which is like a still in towns and cities day by day. The bike is very useful mainly when covering short distances (3-5 km-s). But it can also be used for longer travels as well, e.g. if the biking can be combined with travelling by train, as it is well demonstrated in the developed Western countries. [33]

One-fifth of the travels made by cars of Budapest people inside the city are shorter than 2 km-s. More than half of the travels' distances are shorter than 3 km-s, and three-fourth does not reach 6 km-s. These distances could also be covered on foot, even a bike would not be needed. [34] However, this is just the same in the developed countries. In Holland, 40 percent of change of place are below 2.5 km-s, 70 percent of going on foot and travels are below 7.5 km-s, which still could be covered by bikes.[35] In Great Britain, two-third of the distances to be covered every day are not longer than 9 km-s, and they are fully passable by bikes. [36]

Speed: As regards distances below 5 km-s, mainly in city transportation and traffic jams, there is no relevant difference between travelling by car or bike. And, what is more, if there is a traffic jam, you can move on by bike even on the pavement. This, however, cannot be said of a velomobile as the width in many cases does not make it possible to progress under such conditions.

Weather: You can use velomobile even in severe weather conditions. I can confirm that from my experience. I go to work by velomobile every blessed day! If often happens that it hails, the roads are icy, or snow-bound, it snows, or it is very cold (-11 centigrade) or very hot (+35 centigrade), gust of wind (30-50 km-s/h), it is foggy, or it is raining cats and dogs, to mention just a few characteristics of bad weather conditions.

---

[31] http://www.maut.hu/magyar/sajto/pdf/cikk34.pdf, 2009-06-17
[32] Murlasits Attila és Karlovitz Kristóf
[33] http://www.lelegzet.hu/archivum/1996/12/1141.hpp , 2009-06-13
[34] http://www.antibringa.hu/?bringa-szamtan,18 , Szép régi adatok, 2009-06-13
[35] http://www.khem.gov.hu/data/cms1168940/kerparoskozlekedes.pdf , 2009-06-13
[36] http://www.lelegzet.hu/archivum/1997/01/0765.hpp ,2009-06-13

Power waste: A biker consumes 100 kJ power on the average, while a car uses about 5000 kJ. This is a fifty-fold power waste. This is all the more so if we consider the fact that in most cars there sits only one passenger (on the average, 1.4 person). Let us have a look at exact calculations: One km of riding a bicycle requires 92.09 kJ, going on foot: 261.63 kJ, and riding a car requires 4.83 MJ of power on the average. It means that going by bike is the most efficient means of individual transportation.[37] As regards power demand, a velomobile is more favourable compared even to the traditional bike. On plain areas, a traditional bike can cover about 15-21 km-s per hour with 100-watt power, while a velomobile can reach 28-34 km-s per hour. To take another approach, 271-441 watt power is required to reach a 30-km/h speed by a traditional bike, while in case of a velomobile 79-115 watt is sufficient. [38]

Parking: The space taken up by a bicycle or even a velomobile is only a fragment to that of a car. If you park a car it requires 10 sq metres on the average, where ten bikes or at least four velomobiles can be parked.[39]

Road building and maintenance: Investment and maintenance costs of cycle lanes are only a fragment in comparison to those of building public roads. The cycle lanes take up much less space and the environmental impact caused by their building is much more less as well. The investment costs of 1 km cycle lane in Hungary amounts to HUF 30 million (€ 107 000) on the average. Not much money is spent on their maintenance. Just a few data for comparisons:

building 1 km motorway	HUF 1.3-4.0 billion (€ 4.6-14.3 million)
building 1 km two-lane main road	HUF 0.3-0.5 billion (€ 1.07-1.79)
maintenance of a motorway	HUF 10.0-15.0 million (€ 36-54 000)
maintenance of a main road	HUF 3-5 million (€ 11-18 000) [40]

Depreciation of roads: Wear and tear of roads are caused by vehicles, especially by heavy vehicles. The road damage caused by a truck is much more than that caused by several hundred thousand of cars. [41] Practically no damage is caused by bikes and velomobiles on the roads. A cycle lane gets damaged only if the construction is not satisfactory and the minimum maintenance jobs are not made. As the building and maintenance costs of cycle lanes are only a small proportion in comparison to those of building public roads, therefore all investors could be obliged to build or maintain at least so many cycle lanes as many roads are built or renewed by them.

Permeability of roads: If we consider the permeability of roads from point of view of road capacities, then a two-lane road (7 meters) can be passed by maximum 2000 cars in an hour, which means 4000 passangers if, in the ideal case, we can count with two passengers. In Holland, 6500 bikes can pass a 2.5 meter cycle lane in an hour. [42]

Investment and operational costs: The price of a car is manifold than that of a bike, but even the price of a velomobile is more reasonable (€ 5-8000) than that of a

[37] http://wapedia.mobi/hu/ , 2009-06-13
[38] Frederik Van De Walle: The Velomobile as a Vehicle for more Sustainable Transportation, page 59
[39] http://www.khem.gov.hu/data/cms1168940/kerparoskozlekedes.pdf , 2009-06-13
[40] http://www.nol.hu/archivum/archiv-461960 , 2009-06-16
[41] http://www.levego.hu/kamionstop/kamionkiadvany1.pdf ,2009-06-16
[42] http://www.khem.gov.hu/data/cms1168940/kerparoskozlekedes.pdf , 2009-06-13

car. If the velomobiles would be manufactured in large serials (10 000 pcs), then the price would be considerably decreased. It might fall to around € 3000.[43] It costs about 20-30 HUF/km (8-12 EUR cent) to operate a car, while the costs of a velomobile is roughly 0-2 HUF/km (0-0,8 EUR cent), depending on the ratio between the rider's strength and the electric actuation.

Environmental impacts: Transportation is responsible for 50 percent of carbon dioxide emission and for 61 percent of NO_x emission. A velomobile emits about 0 gramm and a car about 180-200 gramms of contaminants per kilometre. **In Hungary,** between 2003 and 2007, the transportation made by car rose by 29 percent, the truck transportation by 28 percent, the transportation by bus by 3 percent, and the motorbike transportation increased by 10 percent. **On the contrast, transportation by bike decreased by 30 percent.** We can say that a car is about forty-fold larger contaminant than a velomobile. (According to accurate calculations, a velomobile driver with a speed of 25 km-s/h and 80 W, emits 5.2 gramms of carbon dioxide per kilometre.). [44] If we want to be more exact, we can calculate the carbon dioxide emission of the car driver as well because he also breathes even if not so intensively as a velomobile driver.

Health preservation: Somebody making exercises regularly has greater chances to avoid lots of dreadful diseases of modern society. „Short-distance cycling on some days of the week can strengthen the physical stamina as any other sporting activity. In comparison to those people making insufficient physical activities, by cycling six hours daily, heart and circulatory diseases, diabetes and obesity can be reduced by 50 percent and hypertension by 30 percent. According to tests made, optimal prevention can be reached by a daily 20-minutes' cycling. Going by bike to work for example, can also considerably relieve stress. It should be also mentioned that about USD 250 fuel costs can be saved yearly if one covers the 7-km long way to work daily. ”[45]

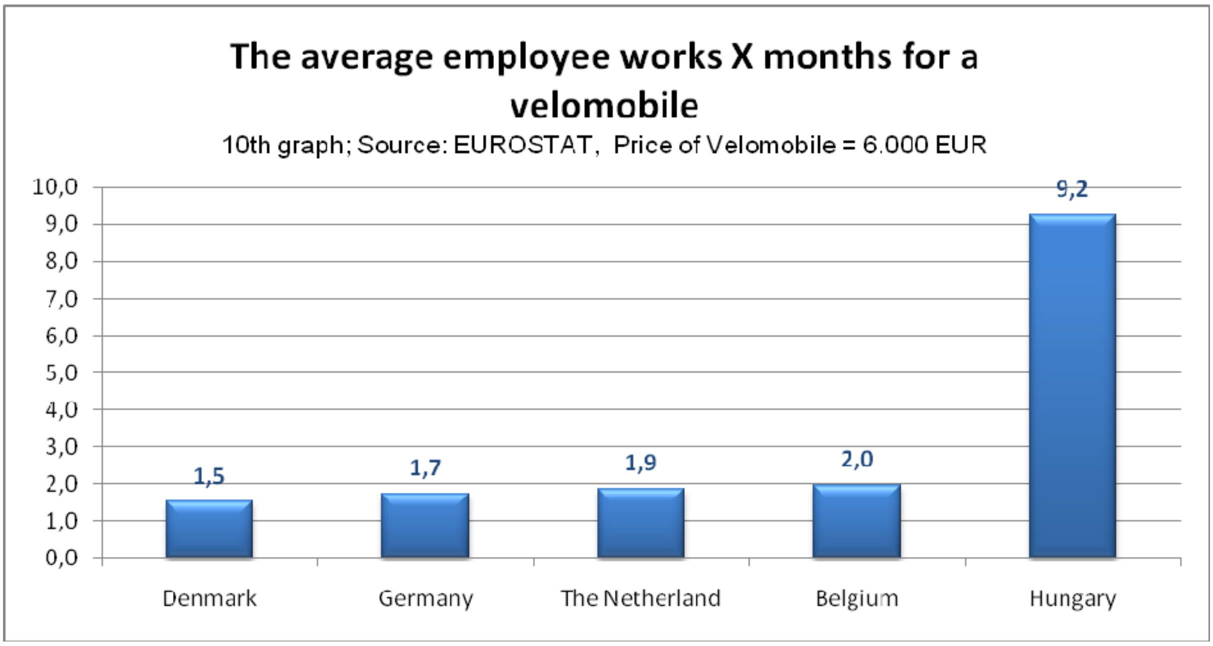
Velomobil price: If we put the average price of a velomobile at € 6 000, then, based on the average salaries and wages, a Hungarian wanting a velomobile has to work more than nine months. In case of developed countries, 1.5-2 months are sufficient.[46] That is illustrated by the following graph.

[43] Van De Walle, Frederick: The Velomobile as a Vehicle for more Sustainable Transportation, page 65.

[44] According to the calculation by Jürgen Eick

[45] http://www.khem.gov.hu/data/cms1168940/kerparoskozlekedes.pdf , 2009-06-13

[46] http://www.epp.eurostat.ec.europa.eu, Earnings in industry and services (average gross annual earnings of full time employees in enterprises with 10 or more employees)



Some typical objections to the question why people do not go by bike to work:

How can I bike in a suit – some people say, though it can be done in good weather and by a traditional bike as well. But you can go by a velomobile, wearing a suit, at any time mainly if the velomobile is equipped with an electric actuation.

How can I arrive at work when I am sweaty: If it is impossible to have a wash at work, then this problem can be solved by a bike or a velomobile which is equipped with an electric actuation because we can pedal so much and with such an intensity that is just agreeable for us.

Consequently, bicycles and velomobiles are not only the vehicle of the poor and sport equipment of the rich. A bicycle can be a means of transportation, can be used for carrying goods and can also be as an equipment for sport, joy and health preservation.

14. What Should a Velomobile be Like if (Going on) Hungarian (Roads)?

Some factors should be mentioned which make the use of velomobiles difficult. Maybe some of them are only Hungarian specialties. The potential use circle can be divided into two groups. Some of them would like to have velomobiles because of the speed, the race and the sport, the other ones would like to buy velomobiles due to environmental consciousness, or because it can be used in all weather conditions and every day. As for me, I belong to this latter group, and so that will be underlined in my viewpoints.

Quality of roads: A bicycle passes on one track, but a velomobile passes on three tracks. You can, even if not easily, avoid road damages by two wheels, but there is hardly any chance for it by three wheels especially if there are cross-ribs of an arm's length and potholes on the road. Most of the Hungarian cycle lanes are narrow that is why broad velomobiles are not very practical though they are more stable. Thus, in our country only velomobiles can be used which are especially massive and have good spring suspension, the construction is higher and they are narrow. (It is somewhat contradictory, however, the ideal Hungarian velomobile would be like this.)

Shoulders and road approaches: Probably it is another Hungarian specialty. In many places, the obstacles between the pavements and the roads are not eliminated. We can often find a 15-20 cm high shoulder, however a real and frequent speciality is the so-called K border. People are inclined to put it in the gateways. It must have been designed by someone who has not ridden a bicycle and has not pushed even a pram. A velomobile cannot climb the high Hungarian shoulders but it cannot roll down either because it comes to a halt and cannot move further. In this case, you cannot do anything else but to get out of the velomobile, and to lift it manually and maneuvre. This problem could be eliminated by large wheeles in the front and in the back, especially good springing and high construction.

Traffic in darkness: I could find out something for all weather and road conditions. It can be solved easily that people see me (light-reflecting elements, rubbers, lamps, flags etc.). However, it is impossible to solve that I, as a velomobile driver, could see in darkness. Not because I am lacking good headlights but because the velomobile is low, and all car headlights, even the dimmed headlights have such strong lights which make me blind. An eye-shade, used also in cars, can somewhat help but thereby the visible field gets also narrower. A further problem is that on the plastic windscreen the light disperses and you can hardly see through it. A hard PVC plate is stable but it spreads light. The soft plate is not stable but it transmits light well. This problem can be somewhat eliminated by combining these two.

Elimination of moisture on the windscreen: The windscreens of velomobiles are usually made of plastic. You can put some kind of wiper on them but they soon will be scratched. Only AERORIDER and LEITRA use glass windscreen. Evidently these types of velomobiles have no such a problem. I tried to solve this problem by two methods. One is an elongated windscreen „projecting roof", which is not nice but practical and efficient. The other solution is the layer formation of the drop remover. That is quite good if it is raining but of no use in snowfall.

Mist elimination on the windscreen: Transparency of the windscreen is prevented not only by the external precipitation but also by the internal mist in cold weather as well. I have used three methods against that. I drilled small holes on the bottom of the windscreen, and so the difference between the external and internal temperatures decreased, and so did the mist. In the back of the velomobile, I built in a 3-W fan, taken out of a computer. Thus I made a forced ventilation. The consumption is minimal, however, it operated properly only if I started it right at starting. When the mist already appeared it did not help remove it. The third solution is to use one-finger gloves, made of some absorbent cloth. It is by this method that the mist can be removed in the most efficient way. If needed, you simply wipe the inner surface of the windscreen.

Getting in and out: As for most velomobiles, it requires a real gymnastics show to get in or out. Most of velomobiles have relatively high side walls, they have the shape of a tub. Exceptions are the types where the whole cover can be opened (Leitra, Butterfly, Thunderstorm). In return, it is more difficult to close them.

Maneouvreability: Most velomobiles are of a tadpole structure. The cover allows only in a limited way to turn the wheel, therefore mostly 7-8 metres are needed to turn (Leitra is an exception to this). In most cases, this is satisfactory, however, there are places on the roads where it prevents from taking a small bend. Consequently, in Hungary those velomobiles are more favourable which have smaller turning radius.

Braking: Due to the very bad conditions of roads, in Hungary it is advisable to mount disc brakes on all wheels. Thereby it is possible that a velomobile could be slowed down or stopped if the driver observes some road damage in time.

Ventilation: Everything undergoes changes, and this is especially true for weather. That is why it is favourable to form a roof which is portable, and can be hidden in the inner part of the velomobile, and with one movement, it can be transformed to conform the prevailing weather conditions (precipitation, wind, cold, warm etc.). I made several trials to solve this, I mounted various combined windscreens. For the time being, one movement is not enough yet, however, everything can be solved from the convertible to the totally closed cover for winter. It is also true that sometimes it is at the expense of nice appearance.

Boot: As for the boot, a velomobile is unbeatable. Almost every type has about 60-100 liters closed loading space. In contrast to traditional bikes, you do not have to bother with fixing the luggage. It is almost impossible to lose the cargo, it will not get wet, and you have easy access to them en route.

Colour and visibility: Yellow colour is recommended, because in this case a car driver can notice the velomobile, mainly in countries where pedestrians and bikers are not highly esteemed. Every available item should be used so as to be seen by others (prisms, reflectors). It is very important that the velomobile should have a flag or blinker at the eye level of the car drivers.

Based on the above, a velomobile running on Hungarian roads should be narrow and high, should have extremely good springing, be of yellow colour, having very good brakes, maneouvreable and should be sold at a reasonable price. You can hardly find such a velomobile, thus, compromises should be made.

15. What is the Spreading of Velomobiles in Hungary Prevented by?

For the time being, conditions for velomobile riding are quite adverse in Hungary. Probably this will not prevent their spreading in the future. The velomobile was received positively and with interest at the places I visited. My website has been visited by more than 50 000 people in the past two years. Several hundreds of car drivers, motorbike riders and bikers face my velomobile on the road section where I go day by day. I am convinced that many of them would happily get in it instead of their metal box if they were in the position to do so.

At first, people are surprised at seeing the velomobile, then they smile and the courageous inquire about it, the most courageous people even test it. Some typical questions: Is it operated by foot or is driven by a motor? Is it not difficult to pedal it? Does anybody sit in that? And the questions always include the one concerning the price. I always answer that it costs as much as a small car. This response seemingly reduces the number of those wanting to buy one. Nevertheless I think, though price can be a grave problem, maybe this is not the main cause which prevents the velomobile from spreading. People spend much higher sums than that for purchasing less useful material goods (e.g. a second car, and lot of smart devices which are superfluous in fact). Or, they smoke into the air the sum which is higher than the price of a velomobile.

All these are well supported by a study made in 12 North-American and European countries. It was stated that the means of transportation and the decisions made concerning this **are not influenced by the income, the technology level or the level of culture or urbanization. In the background of differing decisions there are first of all the decisions made by authorities, municipalities or governments as well as attitudes deriving from public education or environmental views.** [47]

If so, what is their spreading prevented by? We have to admit that the Hungarian wages and salaries, which are well behind to those in developed Western countries, limit the Hungarian demand. In addition, I see two main reasons of the slight interest. On the one side, ignorance and lack of information, on the other side, aspect and attitude hold back the spreading of velomobiles in Hungary for the time being.

If we put the question to a hundred people in Hungary what is a velomobile, then 99 percent do not know what it is because they have not seen but even have not heard of it. Recumbent bikes are better known because several people have already seen one.

Three Hungarian websites dealing with velomobiles can, partially or wholly, somewhat help the lack of information. First of all, those interested in velomobiles can be offered essential facts by the systemic velomobile collection of Mr Viktor Győri[48]. From this site, the websites of all velomobile manufacturers are accessible, and you can read interesting things about velomobiles. The author also offers much new information in his blog. Mr Attila Murlasits[49] enthusiastically propagates recumbent bikes. He gives account of a velomobile of own construction in his high-standard website. He operates a recumbent bike shop which is the single one in Hungary and he has valuable information concerning velomobiles. You can find information on velomobiles and recumbent bikes also on my website[50]. Unfortunately, all of the few Hungarian sources available are listed above.

It must also be admitted that a velomobile is not the goods you purchase without trying it first. A potential Hungarian buyer can get information on the velomobiles on the Internet, however, it is like when you try to appease hunger by looking at the menu… If you want to make a good choice then it would be good to test other types as well. But most of the velomobile manufacturers are about 800-1200 km-s far from Hungary. This is not an invincible distance, however, the vehicle being so far away, makes some people think it over to start off and visit the manufacturers. It would help a lot if there were a model shop in Hungary or near to it where velomobiles could be looked at and tested, just like cars.

Velomobiles are not manufactured for being on stock. You can obtain one only after waiting about 6-12 months, so, a model shop remains to be an illusion. If the potential buyer would like to have a closer look and test the models he has two possibilities. Either he visits Spezi at Germersheim in spring, or a velomobile meeting in autumn. Only a few people are willing to do so for the time being. A further

---

[47] http://www.parlament.hu/naplo34/191/1910049.html , 2009-06-13
[48] www.velomobil.lap.hu , 2009-06-14
[49] www.ambringa.hu , 2009-06-14
[50] www.antibringa.hu , 2009-06-14

obstacle is that velomobile manufacturers are not willing to provide any trade discount. Thus, salesmen wanting to deal with them are not interested, just enthusiastic.

Another obstacle is that less is done than necessary by the state, the authorities so that the environmentally-friendly means of transportation, cycling and thereby velomobile riding could be more and more spreading. Nowadays it is fashionable to speak about environmental protection, but there are only a few people who really do something for it. We are still far away from the critical mass which will bring a breakthrough in the bicycle use.

It seems that the mentality of „let us take it and you should carry it" remains unchanged. It is difficult to represent truthfully the cause of bicycling if the decision-makers, instead of cycling, only speak so as to prove their EU and environmental conformity.

The following examples also prove the lack of responsible attitude as well as the conscious and supportive representation of the environmental protection.

Double measure: As a car-owner, I am obliged to maintain my car in a state suitable for road traffic. If I fail to do so, I will be punished or I will not be given a traffic license. Cycle lanes are possessed by the state or the municipalities, but they are allowed not to maintain them in good state without any consequences. If someone asks them, they innocently open their arms saying, „we have not got the necessary funds". Interestingly enough, when I have to pay taxes, this kind of justification is never accepted.

Environmentally-friendly vehicles, two-person TWIKE-s with electric and manual driving have been manufactured in Germany (previously in Switzerland) for about twenty years now. I wanted to import one to Hungary. However, according to the competent transportation authority that cannot be put into circulation in Hungary because they cannot classify it. It is funny to note that it was possible to classify it in Switzerland, Germany, Great Britain and US.

I made inquiries with the transportation authority whether a velomobile could be put into circulation in Hungary which is equipped with an electric motor of more than 300 W. They were at their wits' end what a velomobile is. They have not seen or heard of one yet. The first official-in-charge replied that this would be hardly possible. I spent much time in anterooms and finally I found an expert who said that if this vehicle had been licensed in an EU country, then it should be accepted by the Hungarian transportation authority as well.

Széchenyi Races have been organized by enthusiastic young people in Hungary for years now where alternatively driven vehicles compete. It is remarkable that no expert from side of offices or authorities is present at the races the tasks of whom it would be among others to encourage and support these initiatives, despite the fact that several creative solutions can be found there. Of some creative participants this year let me mention three-wheeled vehicles as follows: one battery-driven (Pápamobil Mini), one with fuel-cells (Hygo) as well as one operated by solar panels (Pannon Rider). The backwardness of the civilians is well demonstrated by a comment according to which the show of the alternatively driven vehicles is but a ridiculous show without petrol. Though Hungary is not missing creative people, several good ideas appear not to reinforce but rather to destroy each other. In contrast to several European countries, in Hungary there is no organization which would help or coordinate the development of man-powered vehicles.

9th picture Széchenyi Race, Pápamobil Mini, Pannon Rider, Hygo

Source: www.szechenyifutam.hu , Photo: Attila FÖLDI D.

The list can be continued. We can only hope that the spreading of velomobiles in Hungary will not have the same fate as the moped cars and individually-manufactured electric vehicles. These are being banned out from the roads by the authorities with different intensity in the various counties.

The above attitude will preserve the fact that, while one part of Europe awakened, the Hungarian society is still living under the spell of automobiles. Partly, without any doubt, there is no other alternative as you often cannot go even to work by mass transportation. On the other hand, there are several people who use cars more often that it is unavoidable. Car drivers are willing to wait for several hours in filthy traffic jams, poisoning themselves and pedestrians alike though they could go on foot, by bicycle or by mass transportation. The motto is to drive a car by all means, even at the shortest distances. Let us not forget that half of the distances to be covered daily in Budapest are shorter than 3 km-s. It is prestigious to possess a car, the car is leading right after the flat, or rather before it in the imaginary prestige order. It should be as big as possible, as strong as possible and as newest as possible. With some exaggeration it can be said: if you have no car you are not a human.

I am always surprised how many jeeps (idiomatically called „man-of-war") are cruising in towns and cities. Maybe a considerable part of them have not been on a real terrain, it is just fashionable to have them, they are status symbols. „Hey, look here, I can afford even that." Some kind of conservativism can also be observed. People recognize that the velomobile is a clever invention, however, I often see people sneering as if I were imbecile when I speak about the advantages of the velomobile. They do not grasp what is the good of a velomobile. The resistance can be similar to that when the iron horse, the steam engine started its conquest. Today the number of bicycles is estimated at 3.5 million in Hungary. Maybe it also shows some conservativism that, among the great number of bikes, there can roughly be only 250 of recumbent bikes in Hungary. Nevertheless, several people try to make own recumbent bikes.

16. Summary

In contrast to the estimated number of velomobiles, amounting to 1000-1200 in the world, roughly 2100-2300 are now used. The yearly manufacture is about 350 pcs. The manufacture is dinamically increasing, hopefully the yearly production of a thousand pieces will soon be realized. In Hungary, there is one factory-made and one home-made velomobile in use now.

Velomobiles are most widespread in countries where the cycling is natural and is well-developed, e.g. in Holland, Denmark and Western territories of Germany. The general use of velomobiles is in close connection with the development of cycling. Therefore, every factor, which can put the cycling into a favourable position, can speed up the spreading of velomobiles as well.

Environmental impacts caused by transportation, climatic changes, decrease in the energy resources, forceful spreading of transportation at the expense of arable lands, health problems arising from the lack of physical activities, as well as the economic recession keeping on, these all will have the result that material and energy saving and environmentally friendly solutions must be found in the transportation as well. The use of bicycles and velomobiles will play an outstanding role in the lives of people who consciously pay attention to the living spaces of themselves and their grandchildren.

These problems cannot be solved only by improving the harmful internal combustion technologies or even by their changes. The transportation means and their structure must also undergo considerable changes, well-organized public transportation, including railway traffic and man-powered vehicles, bicycles, should be more and more spreading.

The above factors will bring the revival of cycling, the former sport and luxury article will again become an everyday means of transport. A new epoch of the dynamic evolution of bicycles began in the developed countries many decades ago, and this must also be the case in the developing countries. Not only the number of bicycles, but also the number of recumbent bikes and velomobiles will also be increasing.

Gaining ground of cycling mainly depends on the wisdom and intention of decision-makers (governments, authorities, municipalities). It partly depends on how soon they realize that there is no other realistic alternative, and partly on what resources will contribute to the development of cycling as well as the scheduling. This process can be accelerated by the pressing from civilians and their conscious selections.

Though many people think the spreading of velomobiles will be delayed by high prices, the truth is that lack of information, motorization attitude and the conservative views play a greater role. Radical changes can only be reached by the decisions of competent people and the improvement of the use conditions.

We can but agree with the standpoint of the Hungarian Cyclist Club: **Cycling should be an integrated and equal part of transportation.** This viewpoint should be consequently considered with every transportation improvement during the planning, authority tasks and operational jobs. It is impossible to build independent cycle lanes in every street, and there is no need of that. Independent cycle lanes are required in some places (e.g. mainly on freeways and outskirts), but it is generally advisable in the dense municipal road network that the cyclist could go together with other vehicles.

Solutions are good by the help of which the safe traffic of cyclists are based primarily on the mutual cooperation of the participants and not the total physical separation thereof.[51] Total separation from the vehicles gives a false sense of security for both sides, and it does not require due care in the junctions. In municipal surroundings, the bulk and most severe traffic accidents happen in the junctions of cycle lanes and public roads! The risk of accidents can be reduced by careful planning.[52]

We hope when the next Velomobile Conference will be held, perhaps in Hungary, the first sales clerk can state that there are several velomobiles in use and the demand is ever increasing. ☺ And we are confident that the following sarcastic comment, made by a velomobile manufacturer[53] will not become an eternal truth:

„I think Velomobiles are made for a small group of people. Normally the people are stupid and lazy and like to drive cars, there will be no change in the future, so it is a business for enthusastics."

[51] Wolfgang Rauch: Roads for Cycling. Published by the Hungarian Cyclist Association, based on the publication of the Austrian Traffic Club (Verkehrsclub Österreich, VCÖ) 2001

[52] http://www.kerekparosklub.org/tervezesi-szempontok , 2009-06-14

[53] Thomas Seide, 2009.04.07

APPENDICES

1st chart

Velomobile manufactures in the order of total manufactured quantities (pcs)					
	Type of Velomobiles	**Total**	**2008.**	**Country**	**Note**
1.	ALLEWEDER 1-2 (FAW)	500	0	the Netherlands	
2.	LEITRA	299	6	Denmark	
3.	GO-ONE	200	30	Germany	
4.	QUEST 26"	187	73	the Netherlands	
5.	ALLEWEDER 3- 4 (AAW)	170	29	Germany	
6.	CAB-BIKE	150	10	Germany	
7.	QUEST 20"	129	0	the Netherlands	
8.	MANGO	114	0	the Netherlands	
9.	VERSATILE	75	9	the Netherlands	
10.	SINNERMANGO	62	41	the Netherlands	
11.	WAW	60	15	Belgium	
12.	AERORIDER	50	4	the Netherlands	
13.	LIMIT (C-Alleweder)	40	0	the Netherlands	
14.	LEIBA CLASSIC	39	8	Germany	
15.	SUNRIDER	34	26	the Netherlands	
16.	ALLEWEDER 6 (AAW)	20	20	Germany	
17.	LEIBA XSTREAM	15	15	Germany	
18.	BOREALIS (TRICE) QNT	12	0	Canada	
19.	THUNDERSTORM	9	9	Austria	
20.	AURORA NIMBUS	8	0	Canada	
21.	LEIBA BRISE	7	3	Germany	
22.	MILAN	7	7	Germany	
23.	RAINSHADOW	6	1	USA	
24.	LEITRA ADVENCE	5	5	Austria	
25.	BRIES	5	5	Belgium	
26.	ALLEWEDER 5 (AAW)	5	2	Germany	
27.	CABRIOVELO	5	4	Germany	
28.	TRISLED SORCERER SERIES IV.	4	0	Australia	
29.	VELAYO	3	3	Germany	
30.	AERORIDER SPORT	3	2	the Netherlands	
31.	BUTTERFLY	2	0	Switzerland	
32.	BEZERK	1	0	Australia	Estimate
33.	GLYDE	1	0	Australia	Estimate
34.	REFLEX	1	0	Australia	Estimate
35.	TRISLED AVATAR	1	1	Australia	Estimate
36.	BAKMOBILE	1	0	Belgium	
37.	CARCYCLE	1	0	Canada	
38.	LA FLECHE	1	0	France	Estimate
39.	CARNOT	1	0	New Zealand	
40.	BERKUT	1	0	Russia	Estimate
41.	PED-3	1	1	Slovenia	Estimate
42.	BRICYCLE	1	1	USA	
43.	RAINSHADOW	1	0	USA	
44.	STORMY WEATHER	1	0	USA	Estimate
45.	SINCLAR 5	1	0	United Kingdom	Estimate
46.	WEGA	1	1		Estimate
47.	Other velomobiles	60	19		Estimate
	TOTAL	2300	350		

2nd chart

Velomobile manufactures in the order of the 2008-year manufactures (pcs)					
	Type of Velomobiles	**Total**	**2008.**	**Country**	**Note**
1.	QUEST 26"	187	73	the Netherlands	
2.	SINNERMANGO	62	41	the Netherlands	
3.	GO-ONE	200	30	Germany	
4.	ALLEWEDER 3- 4 (AAW)	170	29	Germany	
5.	SUNRIDER	34	26	the Netherlands	
6.	ALLEWEDER 6 (AAW)	20	20	Germany	
7.	WAW	60	15	Belgium	
8.	LEIBA XSTREAM	15	15	Germany	
9.	CAB-BIKE	150	10	Germany	
10.	VERSATILE	75	9	the Netherlands	
11.	THUNDERSTORM	9	9	Austria	
12.	LEIBA CLASSIC	39	8	Germany	
13.	MILAN	7	7	Germany	
14.	LEITRA	299	6	Denmark	
15.	LEITRA ADVENCE	5	5	Austria	
16.	BRIES	5	5	Belgium	
17.	AERORIDER	50	4	the Netherlands	
18.	CABRIOVELO	5	4	Germany	
19.	LEIBA BRISE	7	3	Germany	
20.	VELAYO	3	3	Germany	
21.	ALLEWEDER 5 (AAW)	5	2	Germany	
22.	AERORIDER SPORT	3	2	the Netherlands	
23.	RAINSHADOW	6	1	USA	
24.	TRISLED AVATAR	1	1	Australia	Estimate
25.	PED-3	1	1	Slovenia	Estimate
26.	BRICYCLE	1	1	USA	
27.	WEGA	1	1		Estimate
28.	ALLEWEDER 1-2 (FAW)	500	0	the Netherlands	
29.	QUEST 20"	129	0	the Netherlands	
30.	MANGO	114	0	the Netherlands	
31.	LIMIT (C-Alleweder)	40	0	the Netherlands	
32.	BOREALIS (TRICE) QNT	12	0	Canada	
33.	AURORA NIMBUS	8	0	Canada	
34.	TRISLED SORCERER SERIES IV.	4	0	Australia	
35.	BUTTERFLY	2	0	Switzerland	
36.	BEZERK	1	0	Australia	Estimate
37.	GLYDE	1	0	Australia	Estimate
38.	REFLEX	1	0	Australia	Estimate
39.	BAKMOBILE	1	0	Belgium	
40.	CARCYCLE	1	0	Canada	
41.	LA FLECHE	1	0	France	Estimate
42.	CARNOT	1	0	New Zealand	
43.	BERKUT	1	0	Russia	Estimate
44.	RAINSHADOW	1	0	USA	
45.	STORMY WEATHER	1	0	USA	Estimate
46.	SINCLAR 5	1	0	United Kingdom	Estimate
47.	Other velomobiles	60	19		Estimate
	TOTAL	2300	350		

		Users of Velomobiles																							3rd chart Manufacture	
		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.
	Countries	ALLEWEDER 1-2	QUEST	LEITRA	GO-ONE	ALLEWEDER 3-4	CAB-BIKE	MANGO	VERSATILE	SINNERMANGO	LEIBA	WAW	AERORIDER	C-ALLEWEDER	SUNRIDER	ALLEWEDER 5-6	BOREALIS	Thundrstorm	AURORA	BRIES	Leitra Avance	BUTTERFLY	Others types of velomobiles	TOTAL USERS (pcs)	Users distribution, %	TOTAL PRODUCTION (pcs)	Manufacturer distribution, %
1.	**The Netherlands**	360	228	2	10	75	6	77	60	45	2	10	37	29	29	3							41	1013	44	1193,8	52
2.	**Germany**	68	39	152	140	75	81	19	8	8	48	6	7	5	5	22	2						29	714	31	621	27
3.	**Belgium**	20	11		5	10	5	6	4	2	2	28	2	2	1					5			4	108	5	66	3
4.	**USA**	14	10	17	10	5	13	2	3	2	2	5	1	1	1		3		3				4	96	4	9	0,4
5.	**Denmark**	1	1	74	3	1	5				1	2											4	92	4	299	13
6.	**Canada**	6	4	3	2		15	1		1		3	1				5		5				2	47	2	21	1
7.	**France**	9	6	5				2		1	1	2	1	1	1								1	30	1	1	0,0
8.	**Schweiz**	4	1	16				2														2	1	26	1	2	0,1
9.	**United Kingdom**	8	6	4				1		1	1		1	1	1		2						1	26	1	1	0,0
10.	**Austria**			7														9			5		1	22	1	14	1
11.	**Norway**	2	1	6				1				1											1	12	1		
12.	**Sweden**	1		7				1			1	1											1	12	1		
13.	**Finland**	2	1	1				1			1	1												7	0		
14.	**Japan**	2	1	1				1																5	0		
15.	**Italy**	1	1								1													3	0		
16.	**Australia**	1	1				1																	3	0	8	0,3
17.	**New Zealand**			2																				2	0	1	0,0
20.	**Hungary**										1												1	2	0	1	0,0
18.	**Israel**			1																				1	0		
19.	**Slovenia**			1																				1	0	1	0,0
21.	**Ireland**											1												1	0		
22.	**Others**		5		30	4	24																13	76	3	61	3
23.	**TOTAL (pcs, %)**	500	316	299	200	170	150	114	75	60	61	60	50	38	37	25	12	9	8	5	5	2	103,6	2300	100	2300	100
	Estimate																										
	Type distribution, %	22	14	13	9	7	7	5	3	3	3	3	2	2	2	1	1	0	0	0	0	0	5	100			

Data collection closed on March 31, 2009 2009.március 31.

Manuscript closed on: June 30, 2009

References :

1. Carl-George Rasmussen-Jöürgen Eick: Survival of the fittest, 5th European Velomobile Seminar, Germersheim, 2004.
2. Dutil, [2006.]: World Velomobile Market, Edition 2006
3. Frederick Van De Walle: The Velomobile as a Vehicle for More Sustainable Transportation
4. Frederik Van De Walle: The Velomobile as a Vehicle for more Sustainable Transportation, page 59
5. German Eslava-Reinhold Schwemmer: Cab-Bike Velomobile on a based Modular Concept, 5th European Velomobile Seminar, Germersheim, 2004.
6. http://ambringa.hu/kepek/galeries/Velomobil3_020._l.JPG
7. http://bikemag.hu/kiemelt/varosban-biciklivel
8. http://criticalmass.hu/blogbejegyzes/20081029/valsag-kerekpar
9. http://hu.wikipedia.org/wiki/Magyarorsz%C3%A1g_aut%C3%B3p%C3%A1ly%C3%A1i
10. http://internet.kozut.hu/szakmai/orszagos_kozutak_adatai/kozutakfojellemzoi/Lapok/default.aspx
11. http://szechenyifutam.hu
12. http://wapedia.mobi/hu/
13. http://wapedia.mobi/hu/EuroVelo
14. http://www.antibringa.hu/?aerorider-leiba,25
15. http://www.antibringa.hu/?bringa-szamtan,18 , Szép régi adatok
16. http://www.antibringa.hu/?bringa-szamtan,18, 7. cikk, Bodor Ádám
17. http://www.epp.eurostat.ec.europa.eu, Earnings in industry and services (average gross annual earnings of full timeemployees in enterprises with 10 or more employees)
18. http://www.fenntarthatofejloves.net/2007/03/25/kerekparutak-itthon
19. http://www.harmonet.hu/cikk.php?rovat=258&alrovat=266&cikkid=278
20. http://www.kamba.hu
21. http://www.kamba.hu/index.php?option=com_content&view=category&layout=blog&id=34&Itemid=77
22. http://www.kerekparosklub.org/meghivo-a-velo-city-konferencia-beszamolojara
23. http://www.kerekparosklub.org/tervezesi-szempontok
24. http://www.khem.gov.hu/data/cms1168940/kerparoskozlekedes.pdf
25. http://www.kkk.gov.hu
26. http://www.lelegzet.hu/archivum/1996/12/1141.hpp
27. http://www.lelegzet.hu/archivum/1997/01/0765.hpp
28. http://www.levego.hu/kamionstop/kamionkiadvany1.pdf
29. http://www.maut.hu/magyar/sajto/pdf/cikk34.pdf
30. http://www.nol.hu/archivum/archiv-461960
31. http://www.parlament.hu/naplo34/191/1910049.html
32. http://www.zoldtech.hu/cikkek/20070709elektromoskerekpar
33. Ingo Kollibay: Cyclodyne –the forgotten velomobile, 5th European Velomobile Seminar, Germersheim, 2004.
34. Mészáros, Péter [2006.]: A kerékpározás fejlesztésének szükségessége és lehetôségei – a holland tapasztalatok tükrében, 2006., Budapest
35. Murlasits Attila és Karlovitz Kristóf
36. Stefan Gloger: Desira-Story, 5th European Velomobile Seminar, Germersheim, 2004.
37. Thomas Seide, 2009.04.07 (letter)
38. Van De Walle, Frederick: The Velomobile as a Vehicle for more Sustainable Transportation, page 65.
39. Wolfgang Rauch: Utak a kerékpározáshoz Készült a Kerékpárral Közlekedõk Országos Szövetsége (KEROSZ) gondozásában,az Osztrák Közlekedési Klub (Verkehrsclub Österreich, VCÖ) kiadványa alapján., 2001
40. www.ambringa.hu
41. www.antibringa.hu
42. www.velomobil.lap.hu

Twenty Years of Experience with the Velomobile Leitra

Contribution of Jürgen Eick
to 6th Seminar on Velomobile Design 16. – 17. Oktober 2009

Structure of the Contribution to the Seminar

1. In 1988 I ordered my first Velomobile. Have my expectations been fulfilled?
2. Questions arising from people who have not yet had any experience with a Velomobile and my answers hereto.
3. Is the Velomobile simply fun for sports and leisure activities or is it a mean of transportation?

1. Why did I buy a Velomobile in 1989 and for which purposes have I used it in fact?

From my home to my place of work at the Fachhochschule Wiesbaden in Ruesselsheim the distance was only 5 km. But since 1968 for 20 long years I was irritated every time I had to put on my rain clothes. When I became acquainted to Carl Georg Rasmussen and his Leitra in the autumn of 1988 at the Internationale Fahrradmesse/International Bike Fair (IFMA) in Cologne, I therefore decided to buy this velomobile. My intention was to use it only to get back and forth to work. Rasmussen invited me to help with the final assembly. Therefore in the summer of 1989 I went to Ganløse near Copenhagen where I moved into the Leitra workshop for two weeks in order to work at the velomobile. This way I got a thorough knowledge of the vehicle which enabled me to perform any kind of repair myself lateron.

On my way back home over 1100 kilometers with my Leitra from Ganløse to Ruesselsheim which took 6 days I gained first experiences *(pict. 1)*: Rain and wind and also strong solar radiation could be endured much better than on a normal bicycle. Sunscreen was unnecessary. Later in wintertime a sweater, headband and probably when it was very cold an additional scarf and gloves were sufficient. As time went by I started to use my Leitra more often for longer trips. Even for trips lasting several weeks which I had done with my racing bike before, I changed to the Leitra. Fitness could be trained just as well and longer distances could be covered than with the racing bike without pain in my buttocks, shoulders or wrists.

At the same time one of my two sons had bought a Leitra as well. However he was not able to use it as often as I did. Apart from that he needed the money. Therefore my wife bought it from him in 1993 and for the first time she joined me on a velomobile tour from Ruesselsheim to the Netherlands *(pict. 2)*. In 1995 we went together to Denmark *(pict. 3)*, in 1996 to England *(pict. 4)* and in 1997 to northern Germany *(pict. 5)*. In the autumn of 1997 my wife became seriously ill, but she recovered again during the following months and we were able to undertake some more trips, in 1999 to Switzerland *(pict. 6)*, in 2000 to Sweden *(pict. 7)* and in 2002 once again to the northern part of Germany to visit the watermoated castles in Muensterland *(pict. 8)*. In 2002 my wife became again very seriously ill and died one year later.

In the meantime I have become 72 years. In the whole I have made about 120.000 km with my Leitras. In 2005 I bought my third model, a Leitra-Sport and I use it almost exclusively for 30 km distances around the area I am living in. And yet I still use a normal bike, when I go on tours to the nearby mountain regions of Odenwald and Taunus.

2. Questions arising from people who have not yet had any experien-ce with Velomobiles and my answers hereto.

Question: What is the name of such a vehicle?
It took some time until the name VELOMOBILE has gained acceptance. Today it is being used internationally, as it sounds quite similar in the different European languages and misunderstanding can therefore be excluded.

Question: Is such a velomobile licenced at all?
The questioner might not know that the German Road Traffic Licensing Regulations (StVZO) for bicycles neither regulate the maximal number of wheels nor a weather protection nor the max. width. Therefore even threewheel Sociables on which two persons sit

next to each other are being permitted in Germany. However, the width of a bike *trailer* may not exceed one meter.

Question: What is the price of such a velomobile?
Before I mention the price and in order not to startle the questioner I explain that up to now velomobiles are still being manufactured by hand and therefore the price cannot be compared with this of a used car. I admit, however, that even after this precaution an obvious shock of most of the questioners cannot be avoided.

Question: Driving such a velomobile seems to be extremely dangerous?
In 1994 at the Second International Velomobile Seminar in Laupen Theo Schmidt from Switzerland gave a remarkable lecture on the difference between perceived danger and actual danger. Perceived danger is a very subjective impression. In everyday life as a velomobile driver you will experience that cars pass you with more distance than as a bicycle driver. This is the protection you enjoy because of being different (at least as long as velomobiles are not found in the street more often). In case of accident the velomobile driver is clearly protected better than the driver of a normal bicycle. Documentary evidence has been provided on various accidents.

In case of collision with a pedestrian the risk of injury for the pedestrian is not comparable with that with a normal biker because the soft and well-rounded fairing of the velomobile reduces the crash.

Question: Is it not too hot and do you not perspire very much under the fairing?
My answer hereto does not convince every questioner, but my own experience is that a predominantly white varnish reflects the hitting radiation energy of the sun to an udmost degree, i.e. the difference of the temperatur of the fairing compared to the temperature of the air is negligible. Therefore the thermal radiation of the inner fairing onto the driver is very low. In addition adjustable flaps in the fairing make sure that during driving a more or less strong cooling current of air is being lead onto the driver's body.

If we compare the requirement of liquid for a velomobile driver with the one of a normal bike driver, we will find that due to the fact that only part of the body surface of the velomobile driver is being exposed, less perspiration evaporates, consequently less liquid is required.

Question: Are you allowed with your velomobile on streets, where there are bike trails parallel tot he roads which according to existing regulations ha-ve to be used?
This question leads to the third part of my article in which I want to contribute to the topic being discussed by Velomobilists themselves. The Amendment to the Road Traffic Act (StVO) which will come into effect on 1st September 2009 in Germany, stipulates still the use of bike trails when the well-known blue signs exist (Sign 237, 240 and 241) *(pict. 10)*. Especially fast velomobile drivers do not follow this rule as they do not want to endanger either themselves or other bikers or pedestrians. Usually I pay attention to these signs, but make way for the road, when the bike trail is too narrow or its surface is in unreasonable condition and if I am obstructed by a cycle barrier.

3. Fun for Sports and Leisure Activities or a Mean for Everyday? The Future of the Volomobile from my Point of View.

In the summer of 1998 we founded a Group of Regulars for Special Bicycles (*Spezial-rad-Stammtisch*). Once a month fans of recumbant bicycles and velomobiles have the opportunity to exchange their experiences. We often discuss the question if fast and sporty velomobiles satisfactorily meet the needs of mobility in everyday life. And usually the discussion ends with the observation that not all demands can be fulfilled at the same time. Fast and sporty velomobiles are built narrow, long and low. As a result they have a small cross-section area. Therefore the constructor positions the driver more lying and closer to the street, so that the velomobile might not turn over easily. The fairing of the vehicle often allows the head to be free, so that at least this part of the driver should be cooled by the airstream. As large openings on the fairing contribute to more air resistance the underside is almost closed and flaps for the ventilation of the body are abandonned. Mounting and dismounting has to take place like in a canoe.

You would, however, expect to get in and out an everyday vehicle easily and without having to turn your legs extremely, especially if the driver is not quite as agile anymore. As these velomobiles are often being used in town you should be able to turn sharp bends. Besides that because of safety reasons the eye level of the velomobilist should possibly be the same as the one of the car driver. Narrow bends and too high centre of gravity maximize the danger of turning over. Therefore an everyday velomobile ought to have a comparably wide wheelbase. As a consequence the cross sectional expanse of the velomobile becomes larger (i.e. the Leitra's being approx. 45 % larger than the Quest's). Consequently the air resistance rises. In addition space for a luggage hold must be found, where it can be reached easily and is protected well against rain at the same time. Not only on shopping tours, but also on a trip lasting several days the everyday velomobilist is happy if his head as well as his body are protected carefully against rain. He should not have to look for a special shelter when studying his map or taking a short break.

The difference between the power requirement of a racing velomobile and that of an everyday velomobile can be found on the diagram attached *(pict. 11)* which I drew up based on publications in the internet on the vehicles shown.

As I myself am an everyday velomobilist my own experience is restricted on everyday Velomobiles.

The Leitra has not only met my expectations concerning wheather protection on my way to work, but I owe much more to this vehicle. Only with the power of my muscles I can reach the cities of Frankfurt, Mainz, Wiesbaden and Darmstadt. There I can go shopping, visit exhibitions and lectures and even go to the theatre. I can visit friends and relatives at their places or meet them at any other place. While doing so I always enjoy physical training at the same time. Thanks to my velomobile I have achieved a feeling of independence and well-being. I do not need to carry along any wheather protection. No headwind can frighten me. There is sufficient waterproof luggage hold and I need not waste much time to look for a car park.

I consider myself priviledged in comparison to some other people, because neither due to work nor for personal reasons do I need a car. And I still have the physical energy to move forward without a motor. If only those who, like me are priviledged in s similar way, could force themselves to change from a car to a velomobile, the traffic density of our cities could be reduced considerably. It does not only add to ones own satisfaction, but it offers objective advantages, if one uses a vehicle weighing only 30 kg instead of moving forward a 1,5 t transportation container, which needs fuel or diesel, produces a great deal of CO_2 and for which it is always difficult to find a place to park.

After these optimistic speculations concerning future possibilities of a velomobile as a medium of transport I want to return to the present.

The annual Special Bicycle Fair (*Spezialradmesse*) in Germersheim shows that during the last few years the development of velomobiles has sped up considerably. Elegant styling and perfect processing especially of the fairing gain more and more importance and are being admired by the visitors. However, in my opinion for everyday use other qualities seem to be just as important, as there are vehicle weight, maintenance input, transport capacity, theft security and solar suitability.

Vehicle Weight

Relatively seldom fair visitors ask for the weight of the velomobiles exhibited.

Some weeks ago I renovated my first Leitra of 1989 and prepared it for going home together with my friend from Denmark to Germany. Comparing the weight of this Leitra (29,9 kg) with my Leitra-Sport (36,5 kg) shows clearly that adapting to customer wishes rises the weight accordingly, although the elementary concept has not been changed. The main reasons for the additional weight at the example of these two Leitra-models are *(pict. 13)*: Thickness of fairing, covering of front wheels instead of plain wheel guards, luggage container instead of carrier with textile covering, disc brakes, hydraulic in the front, mechanic in the rear, instead of drum brakes in the front and calliper brakes in the rear, a strengthened front wheel suspension because of more powerful braking with the hydraulic front brake, front wheel hubs with rather big ball-bearings and rims with 35 mm tyres instead of wheel-chair hubs and rims with 22 mm tyres, bottom bracket adjustable to different length of legs instead of a fixed one, last but not least full suspension instead of suspension only on front wheels. A moderate increase of comfort has amounted to a weight increase of 22 %.

In the plain the higher weight is only noticeable during acceleration. Besides these 22 % do not really count taking into consideration the weight of the driver. If you assume a body weight of 75 kg, the gross vehicle weight of the new Leitra is only 6,3 % more than this of the old Leitra. This is unimportant when driving in the plain as air and roll resistance dominate in this case. However, when going uphill, air and roll resistance become marginal while the driving resistance is mainly caused by the gross vehicle weight. 6,3 % more of driving resistance are not to be neglected. Therefore light-weight should be one of the most important aims at further development.

Maintenance Requirements

Today velomobiles are mainly being bought and driven by men. Women rarely count to the group of customers. One reason for this might be that tyres, gearchange, chain and brakes require maintenance and attention which according to experience women do not want to spend time on. But you can scarcely find a helpful bicycle mechanic in your neighbourhood unless he sells velomobiles himself. You have to do it yourself *(pict. 14)*. By using puncture-resistant tyres you can reduce the amount of punctures. The maintenance requirement for gearchange and chain can be reduced by some capital investment, if you decide for a high grade gearhub which allows the installation of a chainguard at the same time. In addition capital investment will also reduce maintenance requirement at brakes: Hydraulic disk brakes are highly functional, reliable and need now and then new brake pads at most.

Transportcapacity

The fairing of the velomobile allows a weatherproof placing of the load. The space provided for it should be reached easily in order to load and unload quickly. On holiday trips it is pleasant to be able to reach at least some of the luggage without having to stop and get off, especially for food and drinks. When arranging the loading space attention should be payed that due to the loading the balance point of velomobile+driver will not be disarranged by the loading carried along. That might lead to an increasing danger of tilting. Additional transport capacity can be provided by a trailer of course *(pict. 15)*.

Theft Security

As long as Velomobiles are only found in the street in a small number the danger of being stolen is quite low. Bicycle thieves usually want to sell their goods quickly and therefore look for normal bikes. However, one might avoid a theft by complicating it to get into the Velomobile and by installing a well hidden parking brake. A cable lock to hook the Velomobile up might also be useful. The constructor of the Leitra recommends a very elegant solution *(pict. 16)*. Here the light seat made of carbon fibre can easily be unhinged from the fixing in the frame and carried along. Without seat the Leitra cannot be ridden of course.

Solar Suitability

Although already mentionned in the second paragraph, here a concluding remark, because mainly riders of normal bikes fear that it might become too hot under the fairing. A white, well reflecting colour and large enough ventilation flaps can only work effectively, if the windows in the fairing are just as large as necessary. An elegantly designed hood made of transparent plastics makes the Velomobile look quite attractive, it is, however, absolutely unsuitable on long trips when the sun shines.

Conclusion

Finally once again I want to point out some important demands that should at least partially be met, if you plan to buy a Velomobile:

- Sufficient physical health and fitness
- Pleasure in regular physical exercise, even if it is a bit exhausting sometimes
- A desire for as much independence of weather as possible on every day trips as well as on holiday tours
- Distances for everyday tours which can definitely be larger than one would cover by a normal bicycle
- Flat or hilly landscape for everyday trips
- The desire for as much mobility as possible at the least possible input of energy and material without having to renounce sufficient convenience.

Jürgen Eick

1

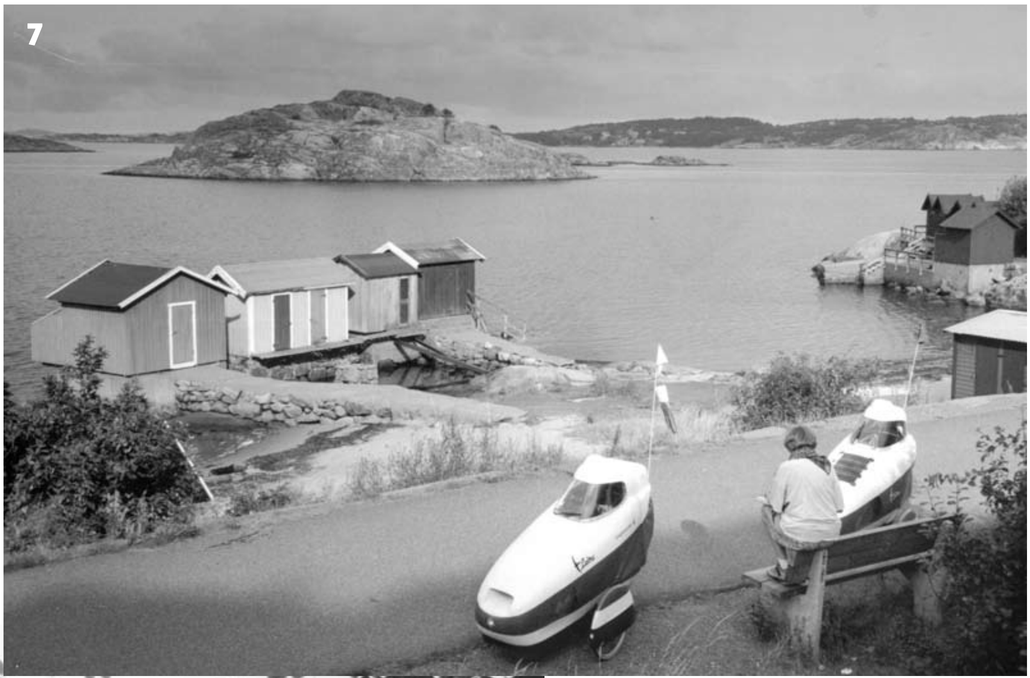
2

3


4
SALE


JOS.L.MEYER PAPENBURG
5


6



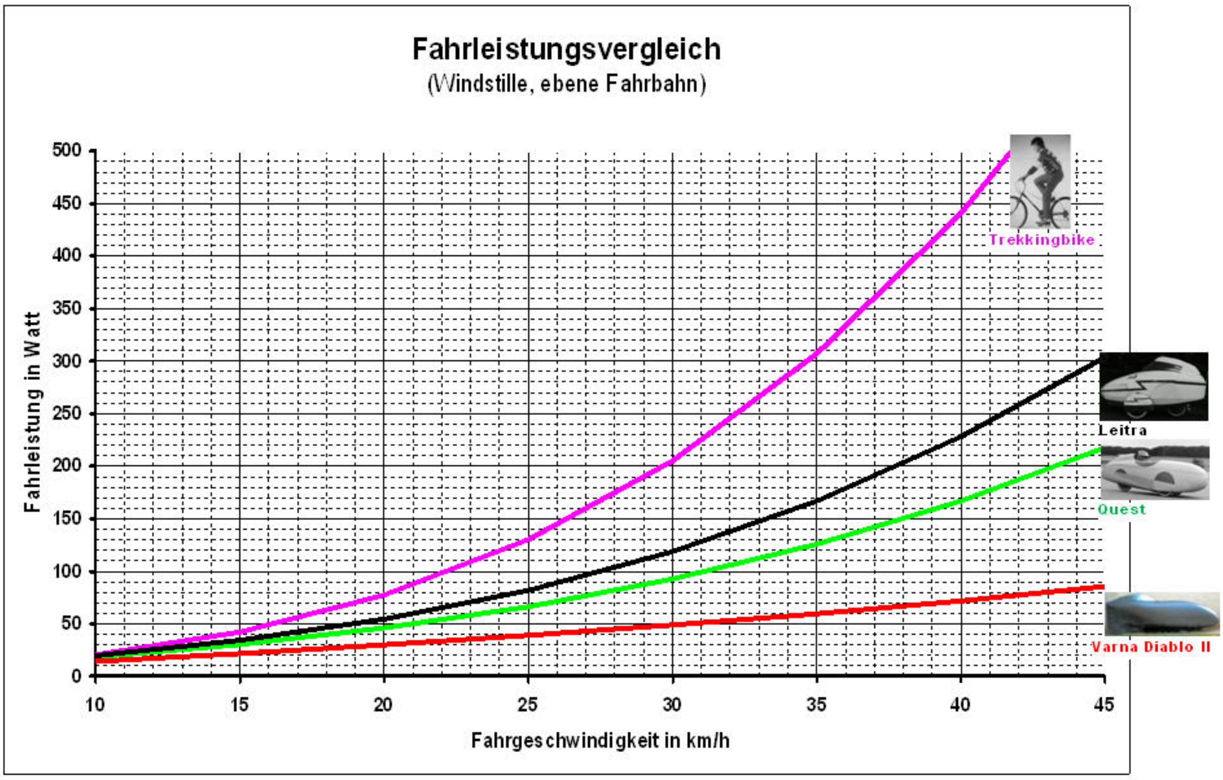
7

8

9

10

Bild 11: Fahrleistungsbedarf von Normalrad und Alltags- bzw. Rennvelomobilen



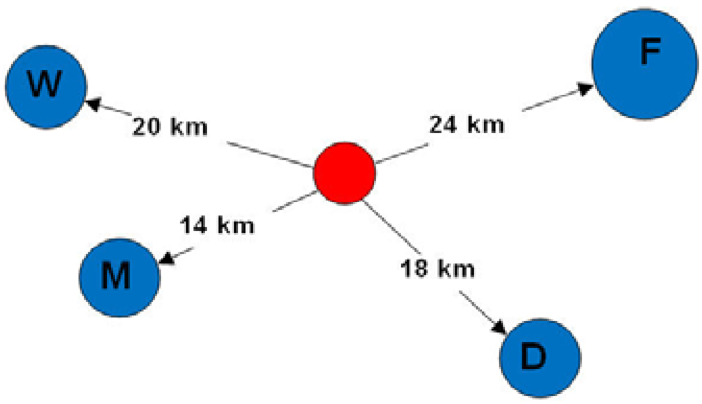


Bild 12: Entfernung zu den nächsten Großstädten

Bild 13: Gründe für den Gewichtsunterschied zwischen Leitra (Baujahr 1989) und Leitra-Sport (Baujahr 2005):

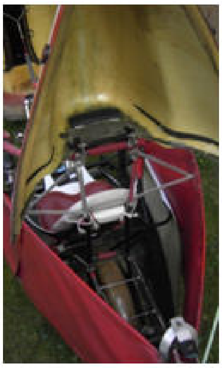
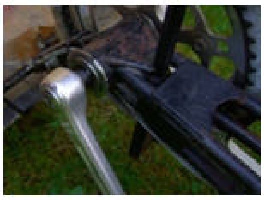
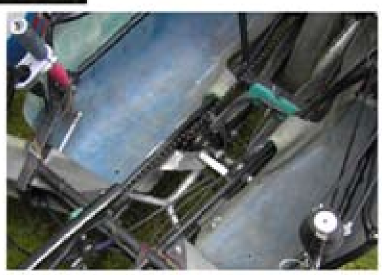
1989 ein einfacher Spritzschutz an Vorderrädern		2005 eine den Großteil der Vorderräder umschließende Verkleidung	
1989 ein Gepäckträger mit seitlicher Stoffverkleidung und Klapphaube		2005 ein Heckkoffer mit Klappdeckel	
1989 Naben mit Konuslagerung und Trommelbremsen		2005 Naben mit Industriekugellagern und hydraulischen Scheibenbremsen	
1989 Vorderradfedern aus gewickelten Carbon-Rovings		2005 verstärkte Vorderradfedern aus Kohlefasermatten	
1989 schmale Felgen mit 22 mm breiten Reifen		2005 Hochflanschfelgen mit 35 mm breiten Reifen	
1989 ein unverstellbares Tretlager		2005 ein auf unterschiedliche Beinlänge einstellbares Tretlager	

Bild 16: Diebstahlsicherung

Ausgehängte Sitzschale

Leitra-Innenraum ohne Sitzschale



CabrioVelo™ and WeatherVelo™

new velomobiles for practical daily use

AUTHOR – Simon Bailey

ABSTRACT - This paper describes two “sister” velomobiles, which have been designed around a common concept: practical personal transport for short to medium length journeys. The *CabrioVelo* is an electrically assisted velomobile with folding roof, developed over many years by Christian Wagner (www.4sev.de) and styled by Jürgen Mayerle (www.schoene-linie.de). The *WeatherVelo* is based on the *CabrioVelo*, but specified by the author for the London market, featuring a rigid roof. This velomobile offers a solution to the pollution and traffic congestion caused by cars in towns and cities. The health benefits of cycling are retained; but with the advantages of greater road presence, weather protection, inherent stability and an integrated luggage box. Various opportunities and challenges of velomobile use in London are also illustrated.

Design Criteria

As well as appealing to existing recumbent riders, the aim is to attract customers who are put off conventional cycling and who instead resort to using a car.

Accordingly, the following criteria apply:

- **Full fairing** (head-in) to provide complete weather protection.

- **Electric assistance** to offset weight of fairing and enable faster average speeds. Increases appeal for riders who are not especially fit or for commuters who are tired after work. Also lessens strain uphill and reduces perspiration on hot days.

- **Safety** – good visibility both from within the velomobile (⇨relatively high seat) and by other road users (⇨road presence, fairing colour, lights etc.). Stable and suitably equipped (sufficient brakes, non-shattering fairing etc.).

- **Aesthetics** – visually appealing styling essential to attract customers.

- **Adjustability** - meaning that the finished velomobiles can all be adjusted for short and tall riders, rather than each velomobile being made to fit a particular customer. *Series production (or mass production) requires an adjustable design.*

- **Comfort** when riding, including consideration of claustrophobia; plus relative ease of ingress/egress (no high step-over or excessive contortions for the rider).

- **Value** –cheap retail price in absolute terms is not feasible for low volume production in Western Europe, but such a velomobile can nonetheless offer good value when running costs etc. are considered (see table on page 5).

Development

The principles behind the *CabrioVelo* have been exhaustively developed during many years of practical experiments by Christian Wagner of *4 Seasons Velos* in Germany. At first, he sold and maintained existing designs of recumbents and velomobiles, which was a natural progression from his background in the car and cycle sectors. Then, Christian started making modifications to improve weatherproofing. These photos show a *Lightning* bike and *Alleweder* velomobile augmented with roofs and opening windscreens:

Despite these improvements, Christian felt that creating a new velomobile would be the best way to optimise weather protection and practicality. Rather than trying to make everything from scratch, he chose the tried-and-tested aluminium *Sinner Comfort* trike (www.sinnerligfietsen.nl) to serve as underpinning. This has an aluminium frame, integrated suspension and good seat height for road use. Onto this trike he built an ingenious folding

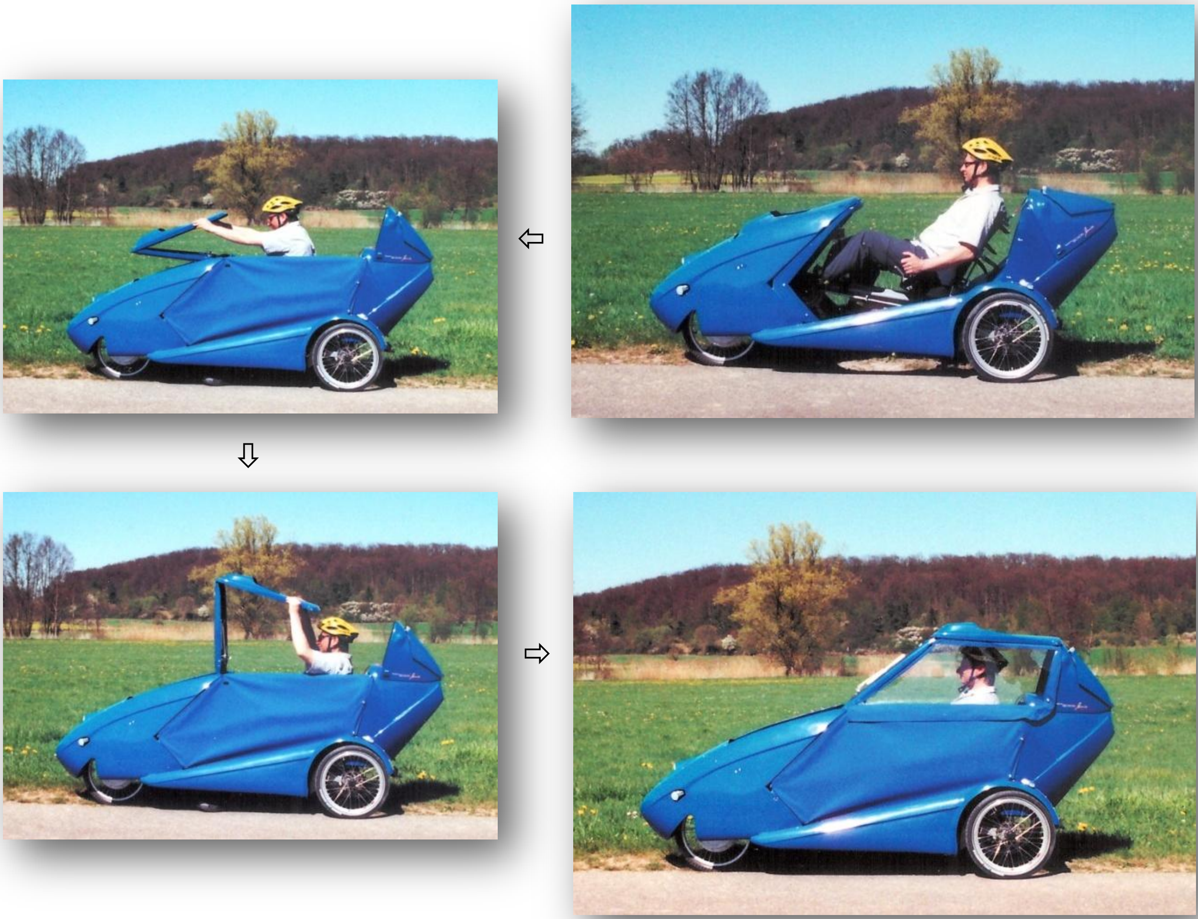
fairing which could be retracted in fine weather (above left) or raised for full weather protection (above right). This folding system also allows easy ingress and egress. The material is durable yet flexible and the colourful stripes are reflective for safety. Two such velomobiles were tested and functioned satisfactorily, but their unusual shape resulted in quizzical reactions from the public.

Drawing on these experiences, Christian embarked on a fresh design. Retaining the *Sinner Comfort* trike, his next prototype featured soundproofed front and rear rigid fairings supporting fabric sides and a detachable roof/windscreen, as pictured below. There is an enclosed luggage box incorporated within the rear fairing and an electric motor fitted to the front hub for assistance. This prototype functioned well and proved to be a useful test bed

for trialling various configurations of electric assistance to cope with the hills of northern Bavaria. Again, the main drawback was the velomobile's appearance, due to a limitation in the construction method for rigid fairing parts, which precluded compound curves. Consequently, public reaction was muted.

Evidently, for marketing a velomobile to customers, it is not enough for the machine to work well. It must look good too. So, at this point Christian approached specialist fibreglass stylist Jürgen Mayerle of *Schöne Linie*, whose previous work included similarly sized small vehicles such as the motorcycle sidecar combination pictured below left, using fibreglass with safety approval for road vehicles.

Jürgen designed a new streamlined fairing shape with folding roof, whilst retaining the proven principles and patented windscreen mechanism developed by Christian. Thus, the *CabrioVelo* was born...



As the photographs above show, a *CabrioVelo* can be rapidly converted from open-top velomobile to fully enclosed velomobile by one person without tools. When stowed, the roof panels fit neatly within the front fairing, as seen in the middle *CabrioVelo* pictured below. This photograph dates from 2007, by which time the author had joined the project after identifying the *CabrioVelo* as the velomobile with most potential for the London market. *[In the background, left to right: Jürgen Mayerle, Christian Wagner, author.]*

These three initial prototypes were made from polyester fibreglass, which is relatively inexpensive but unfortunately too heavy for a human powered vehicle (hpv). So, in order to reduce weight, several experimental mat and resin combinations were tested. Accordingly, subsequent prototypes would be made from epoxy fibreglass: lighter in weight and also with a lower environmental impact.

The potential for velomobile use in London

This table compares personal transport options. It is compiled from a Londoner's perspective, but most factors apply to any European city...

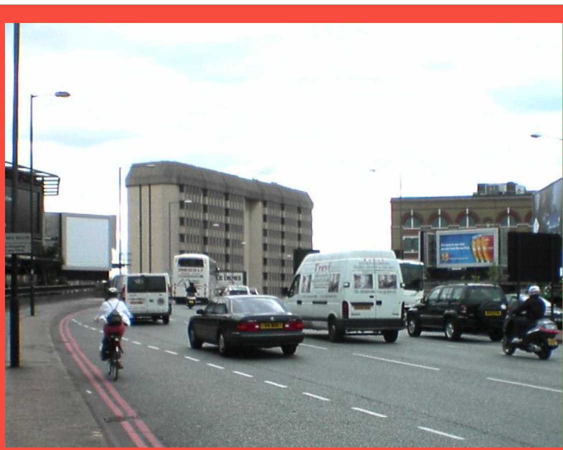
	Bicycle	Velomobile[1]	Scooter / Motorbike	Car
Health benefits	Yes	Yes	No	No
Weather protection	No	Yes	No	Yes
Inherent stability	No	Yes	No	Yes
Environmental damage	Low	Low	Medium	High *(hybrid car: Medium-High)* *(electric car: Low-Medium)*
Running costs	Low	Low	Medium	High *(electric car: Medium)*
Congestion charge, London[2]	No	No	No	£8 per day (€9.25) *(electric/hybrid car: No)*
Purchase cost	Low	Medium	Medium	High
Cuts through traffic	Yes	Yes	Yes	No
Range[3&4]	Short-Medium	Short-Medium[5]	Medium-Long	Long[6] *(electric car: Medium)*
Maximum Speed	Modest (=low)	Modest (=low)	Medium-High	High
Speed in large town or city	Minimal change	Minimal change	Reduced	London averages: 16km/h; 27km/h[7]
Permitted to use cycle lanes	Yes	Yes	No	No

[[1, 2, 3...] please see end of paper for references.]

Velomobiles in the context of London's infrastructure

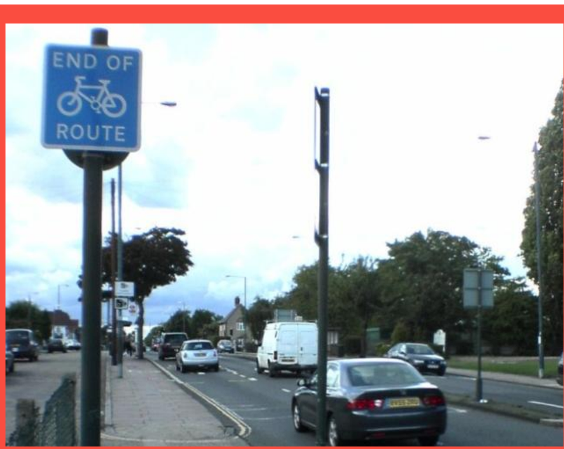
The Mayor of London is a cyclist and keen to improve infrastructure, in the hope of encouraging more cycling. However, years of underinvestment have left a piecemeal situation. The following photographs show examples of **good** and **bad** facilities...

Some busy roads do benefit from separate cycle lanes – unfortunately many do not



A suitably designed velomobile could offer greater road presence than a normal bike

Some streets are one-way for all vehicles except cycles / pedelecs



Fragmented cycle lane infrastructure often covers only part of a cyclist's journey

Remodelled road layout incorporates dedicated two-way cycle lane

A velomobile for London must have brightly coloured bodywork and a good seat height

Examples of London's infrastructure (continued):

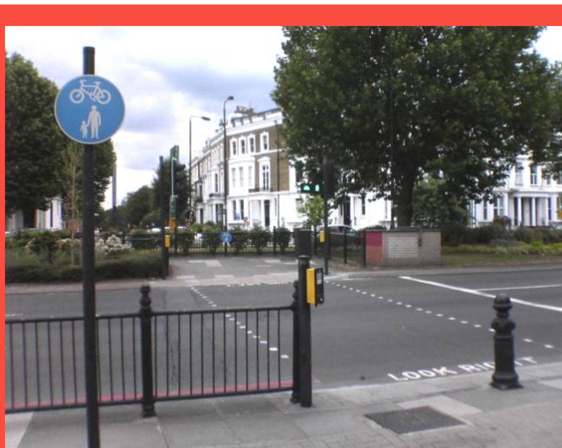
A pedelec velomobile could make use of contra-flow lanes like this

Enhanced acceleration provided by electric assist/drive is important at larger junctions

Another junction with exclusive access to the main road by cycles/pedelecs

Another cycle lane which ends abruptly, tipping the cyclist onto a busy main road

Cycle racks and motorcycle parking bays are common; charging bays are spreading



Shared facilities (pedestrians/cycles) require care: some unsuitable for velomobiles

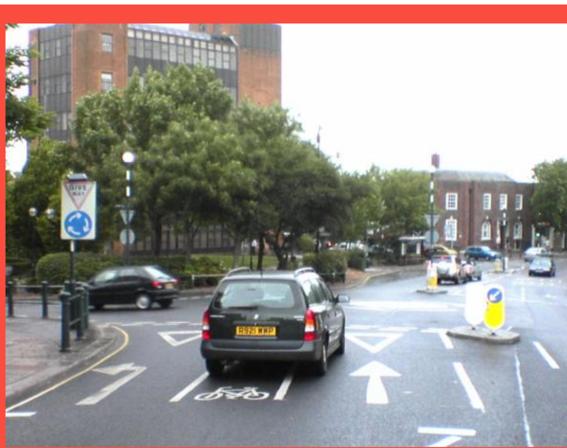
continued on next page...

Examples of London's infrastructure (continued):

Cycles/pedelecs are permitted to use bus lanes across London, bypassing traffic

White lines painted onto an existing road do not create an effective cycle lane

Wide suburban roads allow space for faster vehicles to pass velomobiles safely



Poorly positioned cycle lanes (white lines again!) are frequently ignored by drivers

Narrow two-way streets with parked cars naturally restrict speed of **all** vehicles

Ill-conceived cycle lanes are useless, forcing cyclists to use the road

London's variable infrastructure means that a suitable velomobile would be preferable to a conventional bike, as discussed further in the next section.

Traffic and the Congestion Charge

Congestion exists across London, making the traffic-busting abilities of a bike attractive. However, many people reject bicycling because they feel vulnerable to traffic and exposed to poor weather. By contrast, a well-designed velomobile can offer greater road presence, inherent stability and complete weather protection.

In 2009, around 38 square kilometres (source: Reuters) of central London is subject to a "Congestion Charge". Drivers must pay £8 [≈ €9,25] to enter the city centre on weekdays. The discounted annual charge for a commuter is £1,696 [≈ €1.963].

Certain vehicles are exempt from the charge, if they do not contribute significantly to either congestion or pollution. A velomobile (either cycle, pedelec or moped version) will be exempt. This is a major benefit, enabling velomobiles to gain a foothold in London by helping to offset the comparatively high purchase cost.

Even outer London (pictured right) suffers from congestion. Therefore, the lower speed of a velomobile (compared to the top speed of a motorbike or car) is less important than for rural areas. In crawling traffic, the velomobile can be used as pure hpv. Where opportunities arise, the narrow width of a velomobile enables the rider to exploit gaps in traffic.

European regulations for electric drives

Velomobiles are now recognised by the European Union as a category of cycle, thanks to the EESC's *European Cycling Lexicon*. Copies of this booklet can be downloaded free from http://eesc.europa.eu/documents/publications/index_en.asp?details=1&id=181.

Adding electric assistance provides practical benefits (and fun!) for the rider, but the legal situation becomes more complex for manufacturers. This table represents a summary of the author's understanding, as of July 2009:

Category	**EU regulations**
Pedal cycle	Pedal power only *not feasible for CabrioVelo/WeatherVelo due to weight of fairing* May use cycle lanes No need for driver's licence, nor compulsory insurance[8]
Pedelec and	Exempt from type approval under Directive 2002/24/EC Maximum continuous rated power 250W Maximum assisted speed 25km/h Pedal sensor required (= motor only assists when pedalling) May use cycle lanes No need for driver's licence, nor compulsory insurance[8] Relevant European standard[9]: EN 15194:2009
Low-performance moped (= E-bike) and/or	Requires type approval[10], with some exemptions[11] Maximum power 1kW Maximum design speed 25km/h Pedalling not required (= independent throttle) Prohibited from using cycle lanes Driver's licence and insurance required
Moped (= E-bike) and/or	Requires full type approval Maximum continuous power 4kW Maximum design speed 45km/h Pedalling not required (= independent throttle) Prohibited from using cycle lanes Driver's licence and insurance required

It is worth noting that national regulations can apply in addition to EU regulations, although not in place of EU regulations. This is a particular issue for pedelecs in Britain, where the government's Department for Transport has failed to update regulations from 1983, concerning electrically assisted pedal cycles. The national law does not exactly match the exemption in EU directive 2002/24/EC, causing two absurd possibilities. Firstly, an electrically assisted cycle (velomobile) that is exempt from type approval could still require registration as a motor vehicle, plus driver's licence and insurance. Secondly, a cycle (velomobile) with electric drive which does require type approval might not need registering as a motor vehicle. The author is trying to overcome bureaucratic inertia at the Department for Transport and resolve these absurdities.

A twin-track approach has been adopted for *CabrioVelo/WeatherVelo* electric drives. Christian Wagner is focussing on a moped *CabrioVelo* configuration[12] capable of dealing with the hills of his native Bavaria and with a range of up to 100km. Meanwhile, the author is working on a pedelec *WeatherVelo* prototype suitable for London's flatter topography, shorter distances and viable for use on cycle lanes. However, an advantage of developing "sister" velomobiles is that there is the potential for customers to choose a pedelec *CabrioVelo*, or conversely a moped *WeatherVelo*.

Specifying for city/suburban use

Many components will be identical for the *CabrioVelo* and *WeatherVelo*. However, various differences apply. At the time of writing, changes for the *WeatherVelo* include...

- Permanent roof
  - better rigidity and smoother contours than folding roof
  - high profile in traffic at all times
  - velomobile can be ridden with or without fabric sides fitted (*CabrioVelo* requires fabric sides to be fitted whenever roof is raised)
  - simpler; also perhaps cheaper and lighter weight (analysis ongoing).

- Hub gears, for easy changing at junctions; in preference to derailleurs
  - when using a high gear, riders in towns/cities often need to stop swiftly for traffic lights or other junctions. Hub gears allow the rider to change into a low gear while stationary, and then pull away easily.

- Lithium manganese battery ($LiMn_2O_4$)
  - compact and lightweight; good range
  - no memory effect; can be charged from empty in 3 to 4 hours (10Ah unit), so if necessary a commuter could recharge during the day at work
  - safer chemistry than Lithium Cobalt ($LiCoO_2$).

- Wiper and windscreen
  - hand operated wiper: rain testing by the author proved that at pedelec speeds there is no need for the extra weight/cost/complication/power-drain of an electric wiper. Indeed, <u>intermittent</u> sweeps of a manual wiper are sufficient, thus mostly allowing both hands to remain free for other functions.
  - authorised use of Christian Wagner's patented windscreen design allows anti-fog ventilation and complete opening when/if necessary.

- Efficient LED lighting, including twin “noselights” as well as main front light
  - white noselights increase safety (visibility) when coming out of side roads
  - all of London has street-lighting, so being seen is more important than lighting the road ahead.

- Indicators and wing mirrors [=rear-view mirrors]
  - alternative two-part fabric sides could be offered which allow arm signals.

- Horn and bell
  - loud motorcycle horn for busy traffic; friendlier bike bell for pedestrians etc.

Security is also an important issue. A simple means of preventing unauthorised use of the velomobile has already been tested, by using a D-lock: further research will be conducted. In Britain, a cycle register and electronic transponder scheme exists, supported by the Police.

WeatherVelo mock-up: the white colour of the roof is only for establishing its shape. **Finished versions will be coloured appropriately** to match the other fairing panels.

At the time of writing (July 2009) prototype development of both the *CabrioVelo* and *WeatherVelo* is ongoing. When these “sister” velomobiles become ready for series production it is hoped that they will offer a practical, healthy and environmentally low-impact personal transport option.

Appendix

In an attempt to reduce manufacturing costs and thus purchase price for customers, the author investigated using a trike made in Taiwan (pictured below left) for the *WeatherVelo*, as well as for a simplified "economy" velomobile. This trike is substantially cheaper than any

other with under-seat steering, although it still perceived as expensive in the eyes of the general public, because conventional bikes can be bought for so little. The seat is fairly high, which is good; but the specification is fixed (e.g. no option for hub gears) unless ordering more than 50 units. Furthermore, its steel frame adds weight. Most significantly, the mid-mounted suspension is ineffective and problematic for fitting a full fairing. Many roads in London have a poor surface and speed humps (above right) are common, so the well-suspended and higher quality Dutch *Sinner Comfort* wins out, despite its higher cost.

Explanatory notes (numbers refer to main text)

[1] assumes velomobile has three (or four) wheels, with full fairing and electric assistance (pedelec).

[2] similar scheme planned for the city of Manchester.

[3] 68% of <u>all</u> trips are under 8km. *Source: Cyclists' Touring Club, U.K.*

[4] Average work trip distance for inner London is 8.6km, and for outer London is 11.3km. *Source: Demographia, using data from 2001 Census.*

[5] battery can be charged overnight at home, or even during the day at work to maximise range.

[6] but in practice 58% of <u>car</u> trips are under 8km. *Source: Cyclists' Touring Club, U.K.*

[7] average traffic speed across London is 27km/h. During peak periods in central London this slows to 16km/h (same speed as horse-drawn carriages 100 years ago). *Source: Automobile Association, 2008.*

[8] except Netherlands *[Source: ExtraEnergy]*. In any case, third party pedal cycle insurance is advisable – much cheaper than insurance for a motorised vehicle.

[9] standards are not themselves legally binding, unless referred to in legislation.

[10] or single vehicle approval for low volumes, whereby each velomobile produced is tested individually.

[11] explicit information concerning the low-performance moped category is nebulous. Example exemption from *TÜV Rheinland*: cycle lights are permitted if ISO compliant.

[12] in October 2007 a prototype *CabrioVelo* was granted single vehicle approval by *TÜV Süd*.

Design and Development of the Turanga Velomobile

Suhas Malghan
Turanga Product Development

Abstract

Velomobiles have not entered the mainstream of transportation in the US despite the fact that a velomobile would have great utility to a growing segment of society. This paper describes the design and prototype build process thus far to bring a velomobile designed for the American market and consumer. It's design features include a bamboo/balsa laminate structure surrounded by a lightweight fabric and Coroplast body as well as tilting capability, full suspension, nearly stepless gearing and front wheel drive. The prototype is mid-way through the build process as the chassis has been constructed with the body yet to come. Design, manufacturing and marketing issues pertinent to the US market are also discussed.

Introduction

In an age of high energy costs, roads filled to capacity and the underserving of communities by public transportation systems, there exists a need for a mode of personal transport that requires no petroleum and is suitable congested environments. Velomobiles, fully enclosed human powered vehicles, enable gas-free travel short distances in comfort regardless of the weather. Besides improving the physical fitness of the user, a velomobile saves the owner from the typical hassles of owning a car in the city such as parking, maintenance and insurance.

Company Overview

Turanga Product Development (TPD) was founded in January 2004 by Suhas Malghan as a design firm dedicated to developing sustainable transportation design solutions. Previous projects include the conversion of a 1989 Toyota MR2 to battery electric drive along with the ongoing development of a velomobile, a fully-enclosed, three-wheeled human powered vehicle that allows a rider with cargo to pedal around town in comfort regardless of the weather.

After evaluating the potential to apply sustainable product design processes to other products such as bicycles and motorcycles, the idea of developing a velomobile became the most attractive option due to its incredible potential to transform transportation in the US, a market ripe for growth and the lack of a product designed for the North American customer.

TPD is based in Baltimore, Maryland USA.

Outside of the enthusiast community, velomobiles are nearly unknown in the United States despite the fact that bicycle commuting is enjoying significant growth and many people would appreciate the advantages they would offer. The ability to cover longer distances protected from the wind and inclement weather while carrying cargo is immensely useful to many existing bicyclists while also addressing the concerns of people who don't yet use human powered transportation but are receptive to the idea.

The Turanga velomobile has been designed to appeal to both these groups by offering personal human powered transportation that combines the utility needed to displace short car trips while delivering a riding experience that appeals to seasoned bikers.

Customer Survey

Through many conversations where the idea of velomobiles was presented and discussed with all types of people, it seemed that the responses could be categorized into 3 camps.

- Type A - Hardcore current bikers who already use a bicycle for most of their daily needs year round or nearly so. Take pride in the fact that they bike and are very interested in furthering bikers' rights. Not as enthusiastic about velomobiles as one would think as they are happy with the current state of the art but nevertheless curious. Velomobiles are seen as complicated and unusual. They like light and simple machines and don't want to bother with motor assists and other heavy components.

- Type B - like biking and would like to do more, would do more if circumstances (location, commute distance, traffic conditions, climate, etc.) were more favorable. They're very much intrigued by the idea and often ask about motor assist and integrated child seats (or at least an attachment point for a child trailer). Given, the price premium over a conventional bike, they'd like the velomobile to be versatile enough to be used in may different scenarios.

- Type C - People who don't bike regularly but make nearly all their short trips by car. A velomobile could substitute for the car but the idea meets with great resistance, primarily because the concept of not using a car to get around is so unfamiliar. They may be curious about the idea but believe it is more appropriate for other people.

Operating Environment

Human powered vehicles as a legitimate means of transport are gaining more traction in the US but it is still seen as an accommodation to a special interest group. Roads are still seen as primarily for cars and with a lack of separated bicycle infrastructure, riders are forced to coexist with cars in the same space.

Nevertheless, bicycle use is increasing and city planning is now incorporating bicyclists and pedestrians into the road use mix.

Mixing bicycle and auto traffic requires extra vigilance by both parties and it's very much in the bicyclists' interest to be as visible as possible. Visibility is of special concern as velomobiles are much shorter than typical bicycles and are more difficult for drivers to see when riding alongside. It is especially disconcerting for velo riders' sightline to be at vehicle bumper height. A velomobile will have to find some way to retain the aerodynamic advantages of low height while still being visible to surrounding cars and trucks. Front and rear lights, retroreflective clothing and hand signals help increase bicyclists' visibility and road presence while strong brakes, high maneuverability and a comfortable ride allow the rider to pay attention to the vehicles in the vicinity, confident in the abilities of the machine to handle any situation.

Urban roads in the US are generally rough and pockmarked with pavement irregularities, manholes covers and pebbles and glass at the edges. Riding a bicycle requires attention to the road surface to prevent damage to the bike/rider and possible loss of balance and control.

Velomobiles address these concerns with the stability of three or even four wheels and puncture resistant tires. Yet not all velos possess the ground clearance, approach angles and suspension to handle the speed bumps and short curbs that dot the US landscape. This new design would have to take this terrain into account so that potholes and bumps would be absorbed by the machine instead of the rider.

Weather is also a large variable in the US with nearly every type of climate represented. At our Mid-Atlantic region home base in Baltimore, Maryland USA, all four seasons are strongly represented with cold winters (with a few snowfalls every year), rainy springs, hot and humid summers and chilly autumns. Rain is possible all year round and weather prediction is not very accurate such that it is not uncommon to be caught out in an unexpected rain shower. Daylight hours also swing from 15 hours in the summer to 10 hours in the winter.

A velomobile that could accommodate all these situations would need to provide rain protection, traction to power up inclines through surfaces from gravel trails to snow and enough ventilation that riding is still possible on hot and humid days.

The expense of a velomobile induces a great deal of anxiety in owner's since bikes are so easily stolen. There is nothing like a theft proof bike but it would help if the velo could be secured with a U-lock so theft is at least difficult. Another strategy is to make the velo easy to store in a secure area such as the entrance hall of a building or a secure yard space. A velo would need to have sturdy loops to attach a U-Lock and grab handles for the owner to maneuver the velo into a convenient place. Now what if the velo could be stood on end against a wall or hoisted up to the ceiling with a block and tackle?

Customer Functionality Wants

The velomobile section of the Turanga webpage included a short survey to help understand what prospective customers needs, wants and expectations for this unfamiliar vehicle might be. This was supplemented by many conversations with Type A and B customers as they contemplated how using a velomobile would fit into their daily routine. These conversations were especially helpful as it guided product development to more closely match customer desires, as opposed to copying existing products. The most commonly requested traits included:

- Tight turning radius for maneuverability
- Ability to fit through 30" (762mm) wide doorways
- Weather protection
- Reasonable price ($2000-$4000)
- Cargo room

Just as importantly, comfort features like heated grips were of little to no interest while electric motor assistance met with a mixed reception. Some comments were that they don't want to pay the cost and weight penalty of a battery-electric system and others were not familiar with how an assist system would work.

Common Barriers to Typical Bikes

These conversations were also illuminating as they pointed out aspects of current bike design that the typical consumer finds frustrating. Most of these points centered on drivetrain issues.

Derailleurs and the requisite chain were criticized for the potential for the chain to soil pants legs and the front sprocket to rip cuffs. These points could be addressed with a chain guard yet hardly any bikes today come with one. The multiple speeds offered by derailleurs are welcome but sifting through a wide range of gears trying to be mindful of the proper front and rear sprocket combinations is a tedious affair as well as the inability to shift at a stop. Both of these aspects become more critical when the additional weight and higher speed potential of a velo are factored in. It's much easier to be caught in the wrong gear after a quick stop and then not be able to accelerate with the flow of traffic

Turanga Velomobile Design Process

"Sustainable transportation design" is Turanga's motto and to satisfy that mission the velomobile was designed to make a distinctive statement about sustainability.

The word Turanga has two meanings: in Sanskit it means "horse" and in the Maori language means "place where you stand." The synthesis of these two definitions is the idea behind vehicles that work as well moving as they do standing still. The joy of movement should be complemented by the products' harmony with its environment while stationary. This includes its inevitable disposal.

Along with its environmental compatibility, a Turanga velomobile must share the company ethos of being fun and sporting to ride as well as being functionally and aesthetically refined yet adventurous.

The vehicle architecture developed over several months and was informed by benchmarking a Catrike Speed. The Speed had a very high quality feel but its limitations when used as a commuter quickly became apparent. The 33º seat angle felt too reclined and forced the neck to bend excessively to see forward. The vehicle was also too low as the main spar scraped the pavement when going over speed bumps and riding on the street was intimidating with such a low riding position. The ride was also punishing over bumps as it's naturally harder to avoid bumps when the vehicle has three tracks to hit a bump, as opposed to one of a bicycle.

Turning showed the most vivid limitations of the vehicle and nearly all other trikes; the high speed potential (and the Speed in particular is quite fast) is tempered by the ease of overturning the trike in a turn. The bicycle wheels used in trikes are not designed for lateral forces and resulting deflection due to cornering forces is unsettling as well as resulting in disc brake contact, slowing down the trike. Preventing overturning requires vigorous body positioning that significantly increases rider exertion.

The other dynamic shortcoming discovered was braking stability. Modern disc brakes are very powerful, powerful enough to easily cause "endo-ing" during sudden applications. Unlike a bicycle, it's harder for a trike rider to shift their bodyweight to affect the vehicle dynamics. It was quite easy to lift the rear wheel under braking and there was little the rider could do to prevent that.

This information shaped the chassis design. The customer research, along with the shortcomings described here and shared by most every trike, offered a great opportunity to advance the state of the art. Listed below are several of the key design features along with more in-depth description of the structural design, drivetrain and suspension/steering systems.

Design Features

- Tadpole layout with tilting capability and rear-wheel steering
- Bamboo plywood/balsa sandwich structure for inexpensive manufacturing and easy assembly with future design modifications possible
- Narrow 29" allows passage through doorways and fit in bike lockers
- NuVinci CVT and Schlumpf MountainDrive provide wide, nearly stepless gearing range while being able to shift at a standstill
- Full suspension
- Front and rear grab handles, front handle doubles as "anti-endo" bar
- Full lighting with rear view mirrors and retroreflective visibility markings.
- Enclosed chain runs
- Storage compartment
- Nonstructural, breathable waterproof fabric body with Coroplast structure and full transparent plastic canopy

Structural Design

To meet the overall product goals, the structure needed to be accurate, light, sustainable, inexpensive to manufacture and adaptable to new models and configurations,

The typical welded tubeframe HPV structure is a labor intensive item involving tube bending, notching, fixturing, prep, welding, grinding and finishing. Jigs and tooling are required and the process is mostly manual, hence costly and slow. A better answer was sought.

Many HPVs utilize a monocoque composite structure to reduce weight and part count. This is an attractive option for low volume manufacture but composites are labor intensive, slow and require significant tooling investment. A new configuration of a product, such as adding a new size or seating configuration, would require more tooling investment and take up storage room when not being used. There is also the issue of the large amount of waste inherent in composites manufacturing as well as chemical exposure issues.

Structurally, it is arguable that a monocoque is an efficient structure for this application as there are distinct heavy point loads on the structure as well as areas that handle very little load. Rider weight and pedaling load are quite substantial compared to the relatively paltry aerodynamic loads the bodyshell sees. Unless material thicknesses can be closely tailored to the load profile it is likely to result in a heavier structure than necessary.

The decision process finally wended down to utilizing a main structural spar to absorb the high static and dynamic loads enveloped by a lightweight body. This modularity would allow variations and revisions to be made to one component without affecting the other and concentrate the right material in the correct amounts to the right places.

Organic materials were investigated for their sustainability and aesthetic appeal, especially the bamboo laminates that have a reputation as tough and durable. They also bring an invigorating natural aesthetic to the vehicle that sets it apart from anything on the street. The idea of waterjetting a sandwich laminate was developed as it could result in a quickly and accurately manufactured structure that could be revised without any tooling costs penalty.

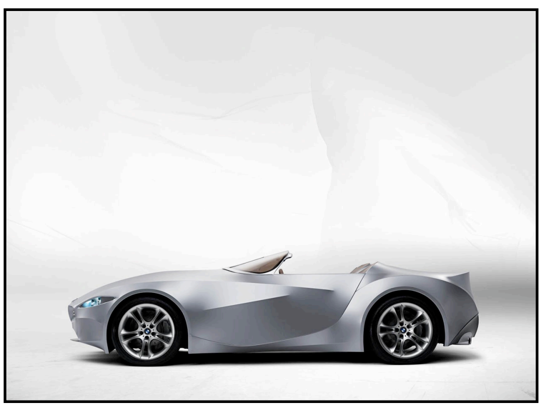
The resulting structure is a boomerang shaped sandwich structure consisting of 1/4” multidirectional bamboo plywood skins on either side of a 1.75” thick balsa

core. The lamination is performed at the balsa supplier’s facility in a hot press and then mounted in a CNC router that cut six spars from an 8’ x 4’ laminate and drilled all the holes for component attachment. The prototype units came out very flat and true but the mechanical routing leaves a ragged edge on the balsa. Waterjetting would leave a cleaner edge but for now the laminate is sealed with two coats of shellac.

The prototype run of spars was also made incorrectly by the supplier, utilizing 1.25” thick balsa but was corrected with extra bamboo laminate. The resulting structure is overbuilt and heavy but more attractive with the contrasting honey-colored panels.

The seat is a similar structure utilizing unidirectional bamboo veneers on either side of a .25” thick balsa core. This piece was vacuum bagged with room temperature cure marine epoxy bonding the laminae together. A higher production technique will be developed in the future but this method was adequate for prototype purposes. It was later manually trimmed to profile with a router. A variety of padding materials are being experimented with, including cork.

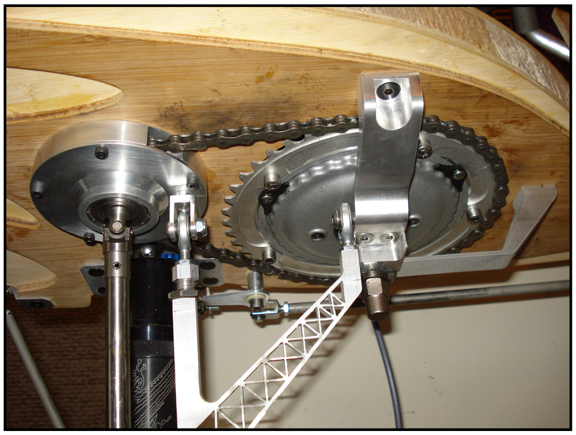
The shell is still in the design stages but the concept of utilizing a waterproof, breathable fabric and Coroplast appears feasible. The inspiration for the use of fabric actually came from the automotive world through the BMW GiNA concept that showed how lively and resolved the body surfacing could be made. The idea of using a fabric cover had been considered and discarded previously as it was not seen as capable of producing an attractive form but the GiNA concept shows the great potential inherent in the material.



Drivetrain

The drivetrain went through many iterations in the CAD program, initally starting with a conventional rear drive layout. The conceptual idea was to utiliize an electronic CVT as proposed by Andreas Fuchs which would provide a clean, shiftless and very flexible drive system that could easily be supplemented with electric motor assist in the fture. Unfortunately, no such system was readily available and after consultations with companies that could develop such a system, it became obvious that development would be far too expensive a project at this time.

A nearly equivalent mechanical system was developed using a NuVinci CVT and



a Schlumpf MountainDrive. Combining these two systems resulted in a wide, nearly stepless gear range that could be shifted at a standstill and was very straightforward to use as there were no permissible chainring combinations that had to be memorized. Neither component is light nor inexpensive though. Chain runs are relatively short and simple; from the Schlumpf to NuVinci to a differential and then out to articulated driveshafts connected to the front wheels. The Schlumpf can be moved fore and aft to adjust to different riders while a spring loaded chain tensioner takes up the slack.

Suspension/Steering

In order to satisfy the disparate requirements such as narrow track and tight turning radius while still leaving room for the rider, the resulting design became a front drive, rear steering, tilting vehicle with air spring/shock units at each wheel.

Given the overturning potential of a trike through studying the benchmark example, a requirement to fit through doors would result in an even narrower track and only exaggerate this tendency. *Also,* though riding a typical trike is fun, it loses the joyful feeling of tilting into turns like on a bicycle. It was decided that if the track was to be narrowed then the velo must be able to tilt into turns. This would make the narrow width achievable as well as enhance the riding experience.

The rider controls the tilting capability with up and down movement of the control lever. The motion moves a linkage that moves the mounting point of the front shock units, hence leaning the velo. The linkage design, track change during tlit and spring preload keep the velo upright in absence of any control input.

Steering the rear wheel is done by moving the levers left and right which are connected to control rods that rotate the rear swingarm. The steering axis is

inclined so that deviations from straight ahead raise the velo, hence a bias toward straight line stability. Maximum tilt angle is approximately 15 degrees, limited by the maximum deflection limit of the driveshaft u-joints.

Future Developments

Even as the first prototype is built the second iteration is already in mind. Often it takes seeing something in the flesh, as opposed to simply the CAD screen, to envision a better way. Several areas that are certain to be developed further are the drivetrain and tilting system/suspension along with part and weight reduction.

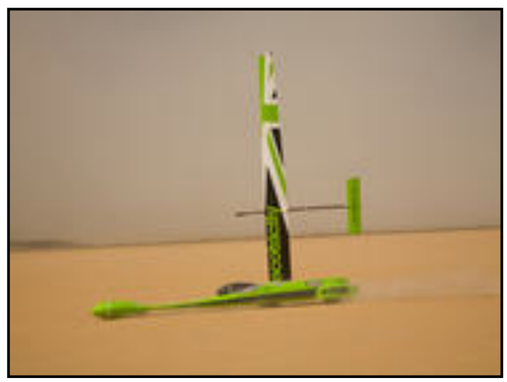
ATC Corporation, the makers of the NuVinci CVT, already offer a microprocessor and actuator kit that can adjust the CVT ratio in response to control inputs. There is great potential in developing this system to deliver the benefits of an electronic transmission at much lower cost. Currently the actuator hardware needs to be miniaturized to aid packaging but hopefully the next version of the system, along with a lighter CVT unit, is forthcoming.

Another advance that was not available during the first prototype build is a belt drive version of the Schlumpf unit. A belt drive would eliminate the mess of chain maintenance as well as save weight and produce less noise.

The suspension design will definitely be revised to incorporate more ball joints to replace the plastic bushing currently employed. This will reduce costs as well as speed assembly. The suspension arms will also be redesigned to make alignment adjustments easier and decrease waterjet time. The rear swingarm will be revised to simplify the spring mount structure. In the midst of these greater changes, the whole design will be reviewed to reduce weight (especially in the structure), refine aesthetics and increase functionality.

A common thread through all these efforts is the need to reduce costs and/or increase value. It remains to be seen whether an initial cost target of $2000-$4000 can be met but it will be pursued with great dedication. A significant fraction of the cost comes from the OEM components used like the NuVinci, Schlumpf and Cane Creek shocks so closer partnership with suppliers to achieve cost savings may be engaged in the future.

Aerodynamic development may also be necessary to ensure stability in cross-wind situations. An interesting avenue of development may be to explore the “apparent wind” effect employed by Richard Jenkins’ Greenbird to recently break the land speed record for wind-powered vehicle at 126.1mph, more than 3 times wind speed.



Manufacturing

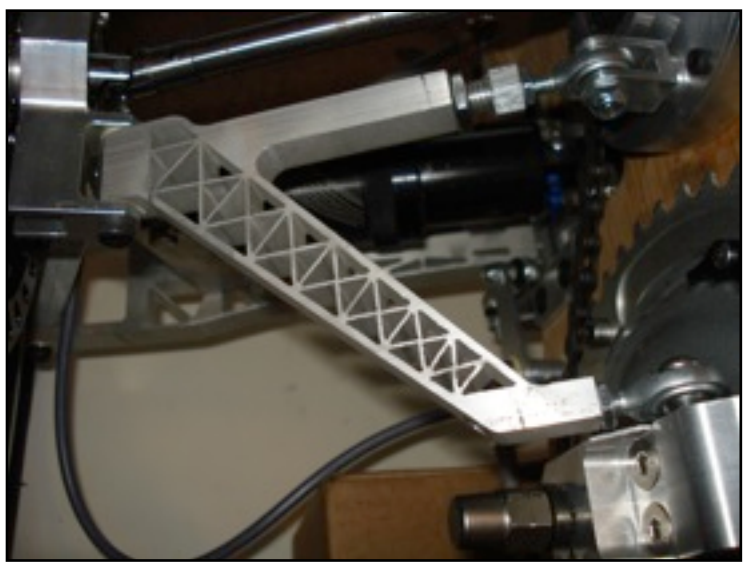
The current state of the velomobile field is of a cottage industry filled with a multitude of manufacturers offering distinctive designs produced in low quantities and with significant lead times. A comparison can be made to the early 1900’s and the infancy of the automobile. As of this writing, the tenets of mass production have not been applied to velomobiles and most are produced using labor intensive methods. This is entirely appropriate to the current sales volume. There are some notable exceptions like the Aerorider and the Flevobike Versatile that make use of polypropylene composites for the structure. Thermoformable composites, as well as being recyclable, are much more suitable to mass production though the tooling costs remain high.

The manufacturing goals set for the Turanga velomobile were:

- Scalable manufacturing costs - Capital and tooling costs should be minimized so that low volume production can be made economical with little to increase in tooling costs as production increases. The number of manufacturing processes, machines, jigs, fixtures and tooling should be minimized.
- Use of environmentally friendly materials - Materials should be fully recyclable and not present any hazard to end user or manufacturing personnel.
- Effective use of material - Minimize cost by minimizing scrap. This means making the most use of stock material sizes.
- Express truth in design through the materials
- Reduce the number of parts

These goals were accomplished in several ways.

Manufacturing methods were consolidated to use as few machines as possible. A majority of the parts were made using waterjet cutting technology. This allows parts to be made quickly from flat stock with minimal time on the mill to cut bearing bores, if needed. In the next iteration, milling time will be reduced even further as bushings are replaced with ball joints. Suspension arms and certain drivetrain components lend themselves to this practice. In addition, components were made symmetrical such that front suspension arms can be used on either side.



Waterjet machining does have its limitations in that a vast majority of machines are only 3-axis, necessitating 2D designs with all operations done in only one plane and one setup. This lends the velo a distinctive style with small cutouts carved out of flat stock. Visually it’s a bit busy but also intriguing and certainly distinctive.

Marketing

The advantages to velomobiles are readily apparent to the growing constituency of people who are concerned about the health of themselves and the planet and are receptive to taking personal action to improve both. To that particular customer, convincing them to buy a velomobile may be as straightforward as building awareness and providing a suitable product at a fair price - a very left-brained proposition built on a logical cost-benefit foundation.

The vast majority of consumers - the type that the velomobile industry must court in order for the industry to grow - have to be convinced that a vehicle more expensive than comparable scooters or bikes yet powered by their own exertion is in their personal interest to purchase. To many customers, the idea of buying a vehicle is specifically to avoid the effort of moving under one's own power. How can a vehicle that requires work to move compete with that. A definitive answer is well beyond the scope of this paper but an appeal to the independent spirit and fun of velomobiling lays the foundation that a velomobile can deliver an experience and emotion that no powered vehicle can match.

Conclusion

TPD is very excited at the potential for a velomobile designed for the US customer and believes development so far is on the right track. Much work remains to be done but a steady level of investment will eventually result in series manufacture.

References

Fuchs Andreas. Chainless Electrical Human-Power Transmissions and their likely Applications. Proceedings of the 1999 Velomobile Seminar. Future Bike Switzerland, 1999

Paper for the
6th European Seminar on Velomobile Design
Copenhagen, October 16-17, 2009

Principles of Human-Electric Hybrid Drives for Human Powered Vehicles

Dr. Andreas Fuchs, Gutenbergstrasse 24, 3011 Bern, Switzerland
andreas.fuchs@alumni.ethz.ch

ABSTRACT

This paper discusses the basic configurations of drive systems for human electric hybrid vehicles.

The e-bikes on the market today are parallel hybrids (PHEB, parallel hybrid electric bicycle). In parallel hybrids it is attempted to mechanically add the highly variable torque of a pedalling human with a constant torque of an electric motor. Some vehicles have the motor near the bottom bracket, while others use motors near or in the front or rear wheel. A special case of a parallel hybrid is Michael Kutters drive system where electric and human power are added using a planetary gearset in the rear wheel hub.

In a series hybrid human electric hybrid (SHEB, series hybrid electrical bicycle) human power is converted into electric power using an electric generator driven by the pedals. Mechanical drive power to move the series hybrid vehicle is produced by a motor driving the wheel just as in the case with the parallel hybrids having either a front wheel or rear wheel (hub) motor.

The different kinds of hybrid drives and their disadvantages and benefits with respect to use in recumbents and velomobiles as well as in upright cycles are discussed.

Introduction

Humans are easily capable to deliver up to between 75 to 200 W pedalling power over hours. This power level is sufficient to cycle at constant speeds higher than e.g. 15 km/h in flat lands.

However, against crosswind, on slopes, and especially in stop-and-go traffic power-levels of up to seveal hundred watts are at least sometimes required to keep cruising speed up, e.g. at more than 10 to 15 km/h.
Non-athletic humans can deliver power above 200 watt levels only up to some minutes. Therefore, power from other energy sources such as batteries is welcome in driving situations requiring power levels high compared to a humans constant power range. Hybrid drives, combining human power e.g. with electric power, is a relevant topic when searching for very ergonomical muscle powered vehicles especially for use in urban aereas where stop-and-go is common.

The mechanical ouput power of the bipedal human is highly rippled: Torque varies from two times average torque to sometimes below 0 Nm! This fact raises the question which hybridisation methods are more feasible for a certain application than others.

In vehicles with mechanical coupling of human and electric machine, both drives are arranged in a parallel setup. Therefore the name “parallel hybrid”. One could call these cycles also “electromechanical cycles”.

In vehicles with electrical coupling of human and electric machine, both can be loaded optimally since they are mechanically independent from each other. Human and motor are arranged in series, and hence the name “series hybrid”. Since the transmission of human power is purely by electrical means, mechanical transmission elements are totally lacking. One could call such cycles “electronical cycles”.

Comparison of Humans and electric Drives

With respect to propulsion of partially or fully human powered light vehicles, humans and electric drive systems - comprising battery, motor controller and electric motor - share some similarities, but some important features are dissimilar.

Energy Storage and Power Delivery

The human as a biochemical energy storage and the batteries as electrochemical storages deliver power for durations of between seconds and hours. If power demand is very high, “discharge time” becomes very short, in the order of seconds. If power demand is low, power may be delivered over hours or even longer. However, humans deliver on a much lower power level (power per unit weight).

To deliver the power for acceleration or for fast climbs, batteries are welcome as additional sources of drive power. On timescales typical for commuting rides, minutes to an hour, the higher energy density of batteries may be welcome to go faster than on human power alone. Even lead gel battery, known as a battery with low energy density, has about 15 times more energy content per unit weight than a human.
So, for short rides, especially if speed is not constant, combining human power and electric drives makes sense. However, for very long trips typical for bicycle touring in remote places, electric drives are not ideal. For long trips, very lightweight drives like the ones which mainly help on hills but not in the flats may make sense (Tetz, 1999).

Speed Range

In mechanical bicycles, gears are used to adjust the wide speed range of the bicycle wheel to the more narrow pedalling speed range of the pedalling human.

Within the human population, preferred pedalling frequency varies from below 50 rpm to above 90 rpm. Pedal frequency while cycling in the flats at an easy pace remains constant within a few rpm, while pedal frequency varies during phases of acceleration, and before and during gear change. In general, humans pedal slower when going uphill.

Maximum cadence of humans is typically below 120 rpm, while electric machines may turn easily many thousand times per minute.

The speed of the crank arm and the pedal varies slightly throughout one pedal axis revolution. Operating electric drives as energy-efficiently as possible requires a speed as constant as possible. However, very dynamical electric drives are possible.

Torque Output

Average torque varies within a sample of human beings. Trained cyclists may pedal with torques that are more than twice as high as torques by untrained, elderly, weak/ill or handicapped persons.
Humans and electric machines are very different regarding time history of the produced torque: The bipedal humans produce torque with a very high torque ripple (-> Fig. 1). Ripple can be in the order of 100% of the time average of the output torque! Each leg produces a maximum and a minimum torque per one pedal revolution. Torque sometimes is even negative, so that over a certain angle of pedal revolution the pedal is braked rather than pushed.

Conversely, rotating electric machines produce constant torques with some superposed ripple usually small compared to the ripple of a bipedal human.

How two such different drive machines like a human and an electric machine can be coupled in a hybrid vehicle is discussed below.

At speeds different from zero, the (time averaged) torque-speed characteristic of humans and electric machines look quite similar. The faster the “machine” – human or motor - runs, the less torque can be delivered to the pedals or to a wheel.

Both human and electric machines, at a certain speed, can deliver torque over a huge dynamic range. For seconds, electric machines can deliver peak torques of up to 10 times nominal torque. For minutes, humans and electric machines may easily work at 300% of nominal power.
At or near zero pedal speed or when pedalling in a standing rather than seated position humans may produce extremely high torques at the pedal, corresponding up to a small multiple of the body weight.

Cooling

Humans are foreseen to sweat in order to be cooled. Evaporating water is definitively a very effective way to cool! However the water lost by sweating has to be replaced by drinking.
In light electric vehicles, batteries, motor controller and motor usually are not water cooled in order to keep weight and mechanical complexity of the drive system low. Passive cooling by heat conduction from energy-storages (batteries) and -converters (controllers) to the vehicle frame, or by convection or radiation to air, is common practice.

	Human	**Battery**	**Electric Motor**
Torque	Between 10 and 30 Nm time averaged torque. High torque ripple	-	About 1 Nm/kg nominal torque. Low torque ripple
Maximum output power (time domain: some seconds to minutes)	At most 7 W/kg	Up to > 1 **k**W/kg	Up to about 1 **k**W/kg
Energy density of storage	About 2 Wh/kg	Better than 15 Wh/kg, up to more than 100 Wh/kg (e.g. lithium batteries)	If recuperation is possible, kinetic or potential energy of the vehicle may be stored in the battery

Table 1 Comparison of humans and electric drives.

A closer Look to Torque Ripple

Let us look at a situation where two hypothetically identical cyclists pedal a tandem. The similar torques they produce sum up thanks to the chain between captain and stoker. Since at every position of the crank the output torques of the legs of the two **ideal** cyclists are equal (see Fig. 1), there is no interference. E.g. the legs of cyclist 2 are not accelerated by pedal pushs of cyclist 1, and vice versa.

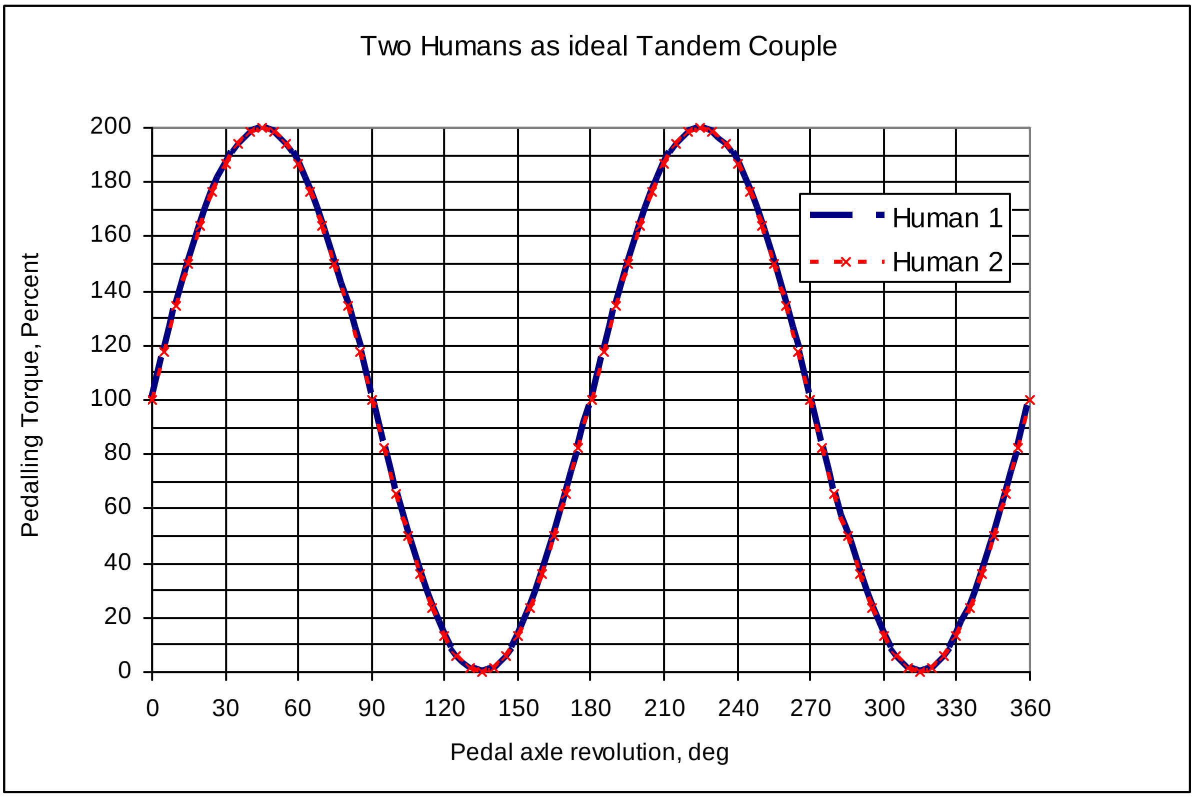


Fig. 1 Example for the output torque history in an ideal human tandem: Both cyclists deliver the same torque at the same crank position.

In real tandems, two different humans – “non-ideal cyclists” - push the pedals; see Fig. 2. Their torque history is different, the leg masses are different. While one leg of cyclist 1 is pushing, an other leg of cyclist 2 may be braking (excentric mode of leg-use). Some interference of cyclist 1 and 2 is to be expected, although small enough at typical cycling cadences. The interference between the cyclists may be bigger when climbing at low cadence and high pedal torques.
In fact, when multi-person mechanical cycles climb, total propulsion power is less than the sum of the power contributed by each cyclist since there are losses due to interference between the pedallers (Ruedi Frei, personal communciation. ca. 1999). Interferences may be reduced by freewheels between the cranks or gears of the cyclists of a multi-person cycle; as a consequence, total mechanical output power increases.

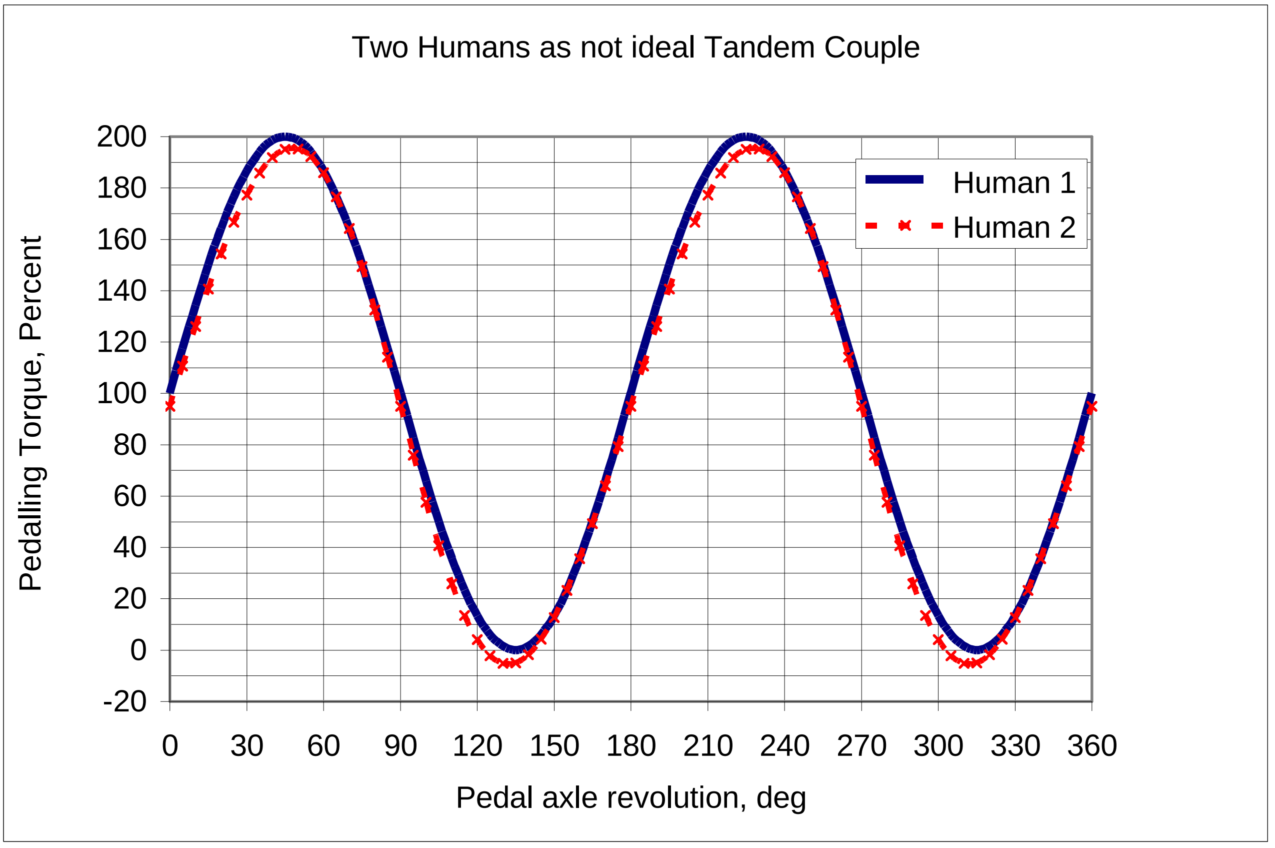


Fig. 2 Example for a less than ideal torque history of a real human tandem.

A human and an electric motor have very different torque histories, as is shown in the figure 3 below. Compared to a tandem of two human cyclists, human and electric machine are a very non-ideal tandem couple!

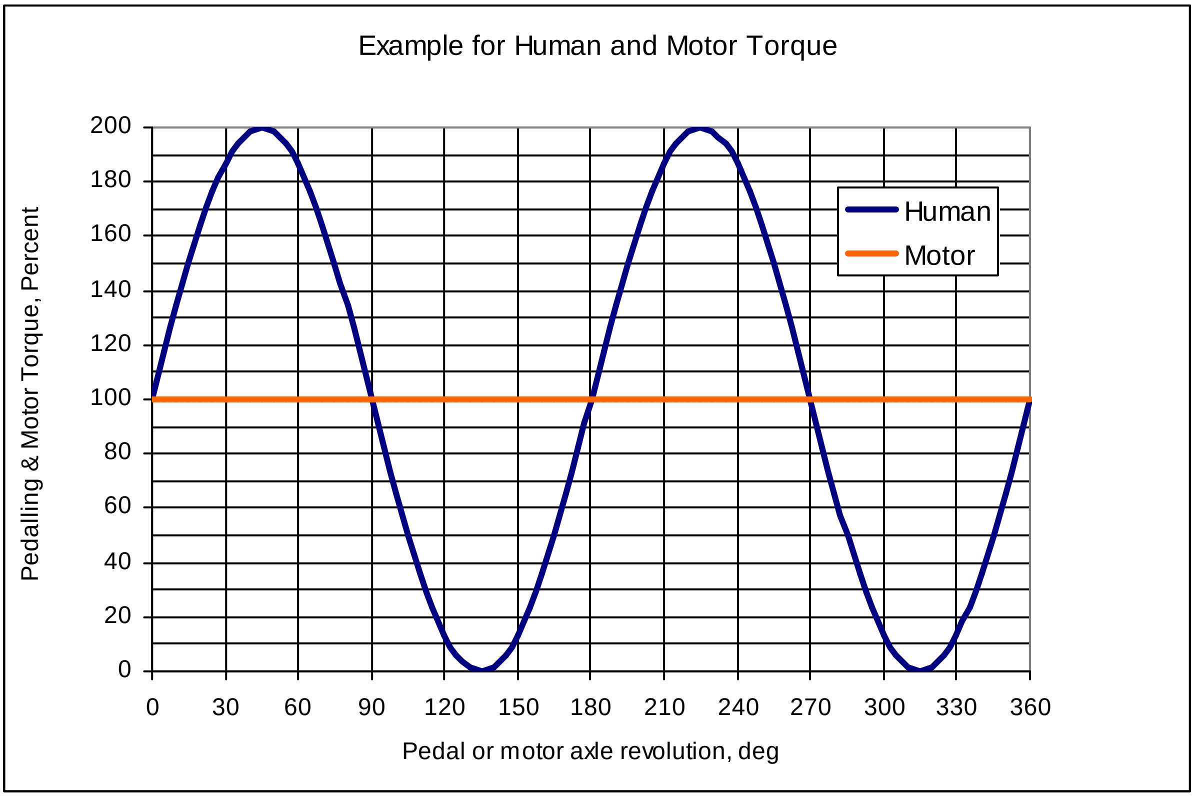


Fig. 3 Typical torque histories of human and electric machine (idealized: no torque ripple, on the output of the electric machine).

The motor torque could vary in such a way as to compensate the torque ripple by the human pedaller. A constant torque at the wheel could be achieved by 180 degrees phase shift between human and motor as shown in the next figure.

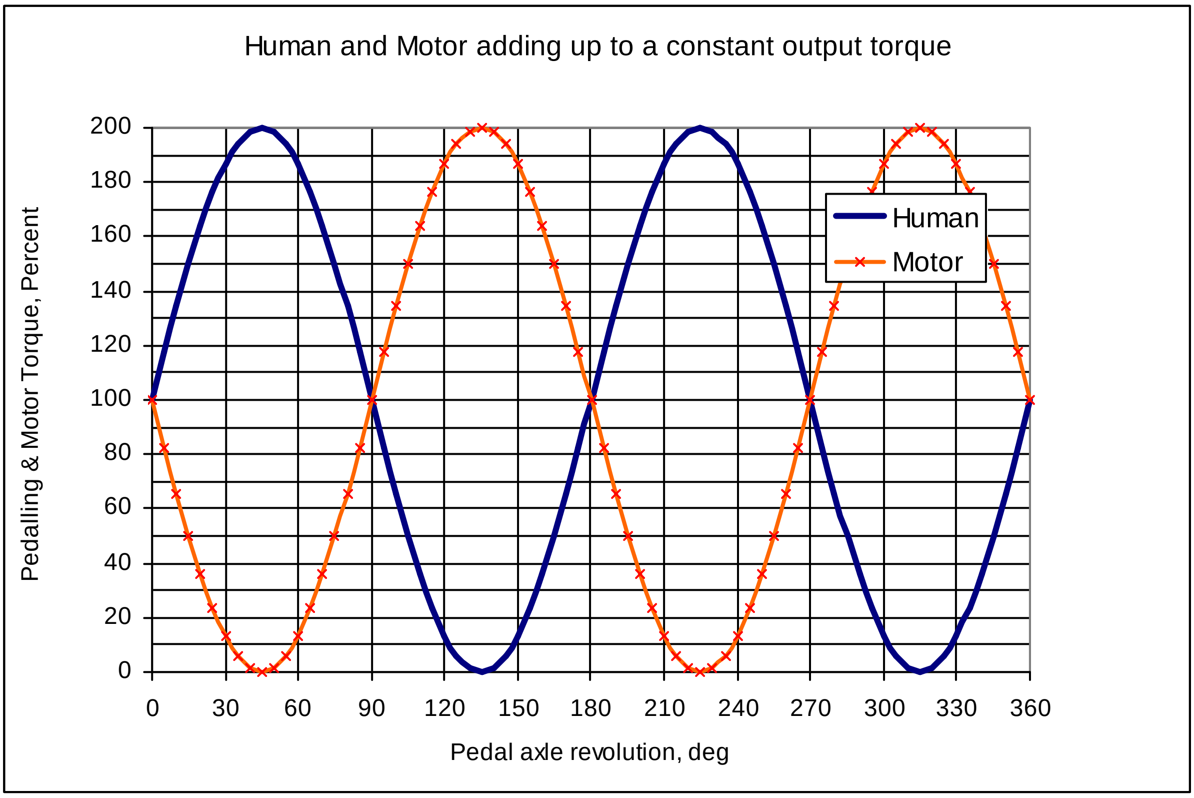


Fig. 4 Example for torque histories of human and motor that would yield a constant added up torque to drive the wheel.

There exist hardly any published research papers about combining two such dissimilar “motors” like humans and electric machines in the form of a hybrid drives for vehicles.
Due to this lack of information, today only performance measurements on existing parallel hybrid vehicles can be used as a basis to compare different ways of hybridisation. See below.

Mechanical and Electrical Coupling of Human and Machine

Mechanical Coupling of Human and Machine

The task of hybridisation requires to find an axle somewhere in the drive train of a parallel hybrid human powered vehicle rotating at a certain speed so that both human and motor can apply torque to that axle. This situation is comparable to a tandem, where there is no second cyclist (stoker), but an electric motor.

	Speed (Range), rpm or km/h	**Direct drive torque, Nm**
Bottom bracket or chain drive	Cadence of cyclists (about constant for a person at a certain level of training)	15 =< Nm =< 120, torques between 20 and 40 Nm being most probable
Rear wheel	Speed of vehicle, 0 to maximum speed (*)	20” (xx-406): 57 Nm (**) 26” (xx-559): 74 Nm 28” (xx-622): 80 Nm
Front wheel		

Table 2 Positions in the parallel hybrid drive train where the addition of the torques by human and motor can take place.
Speed range of cyclists is between 40 and 120 rpm, most common between 50 and 80 rpm. Speed range of vehicle varies in dependence of vehicle class, wheel size and legal requirements. 25 km/h to 45 km/h corresponds to about 260 to 470 rpm of a 20” wheel.
The torques required to start either in the flat or on the hills are given for the situation where power assist is 100% (no help by the pedalling human, electric drive working alone). If the power assist ratio is 50%, these values have to be halved.
If gears are used, hence if non direct-drive, then these torques are to be divided by the gear ratio.

* Elektroantrieb.at uses belts from motor to a big wheel parallel to the wheel rim. Other drive the wheel by pressing rolls onto the tire.
** Torques at the wheels at 150 kg weight and 15% slope

Since cyclists pedal with a low frequency compared to the frequencies of turning wheels, mechanical cycles use speed-increasing gears.
Bottom bracket or chain motors first use speed-reducing gears (if not direct drive such as the Swiss Flyer model F electric bicycle), and then use the speed-increasing gear of the traditional bicycle-transmission.
Conversely, the motor drives that act onto the wheel directly use speed-reducing gears only.

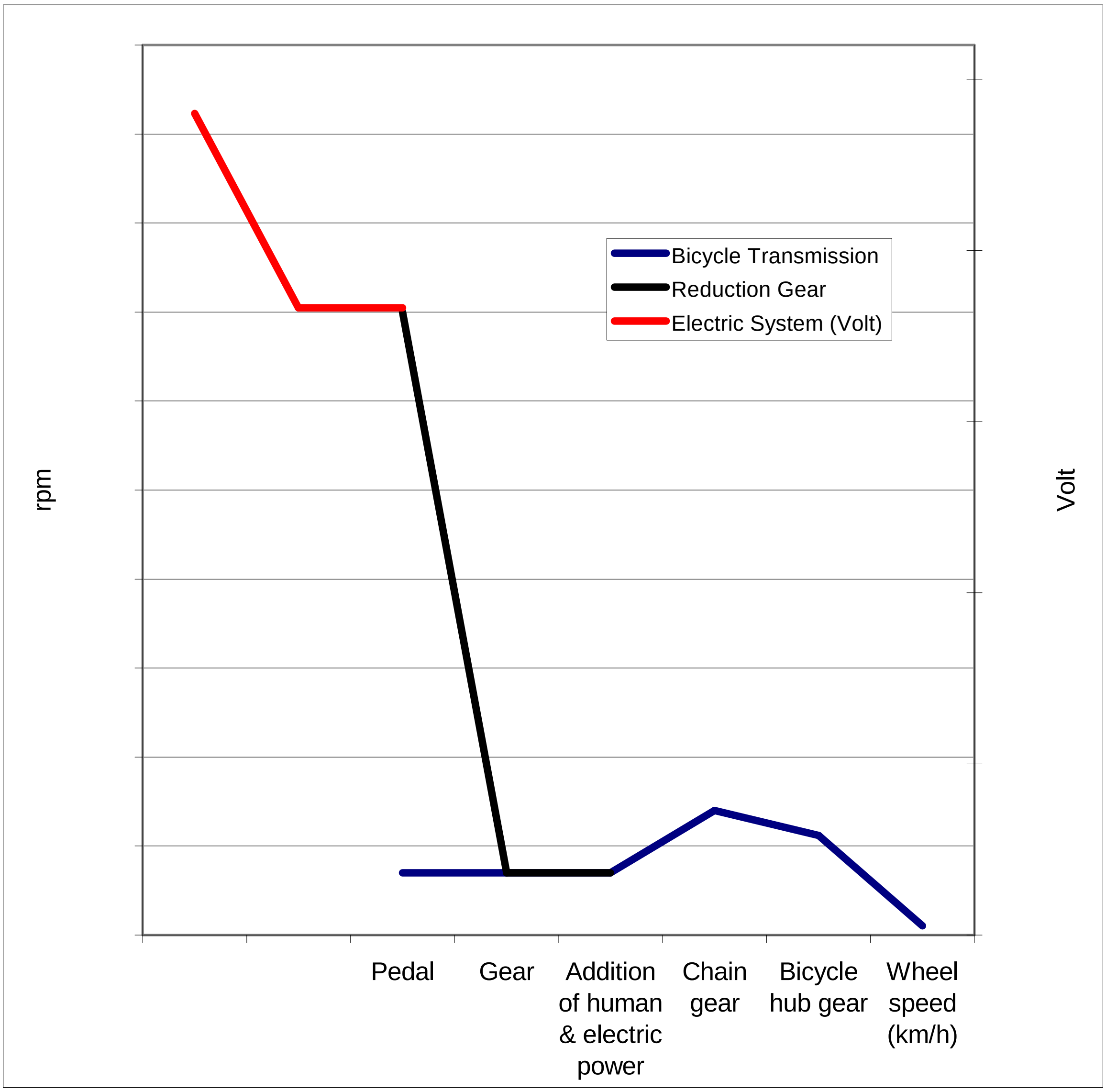


Fig 5a Schematic, qualitatively showing speed and voltage (electrical equivalent to speed) in an human electric hybrid drive with **bottom bracket motor**. Speed of the motor is reduced to the speed of the pedal or the chain, in order to then increase it again.
Electric system (red): The battery voltage is reduced by the motor controller to set a certain motor speed.

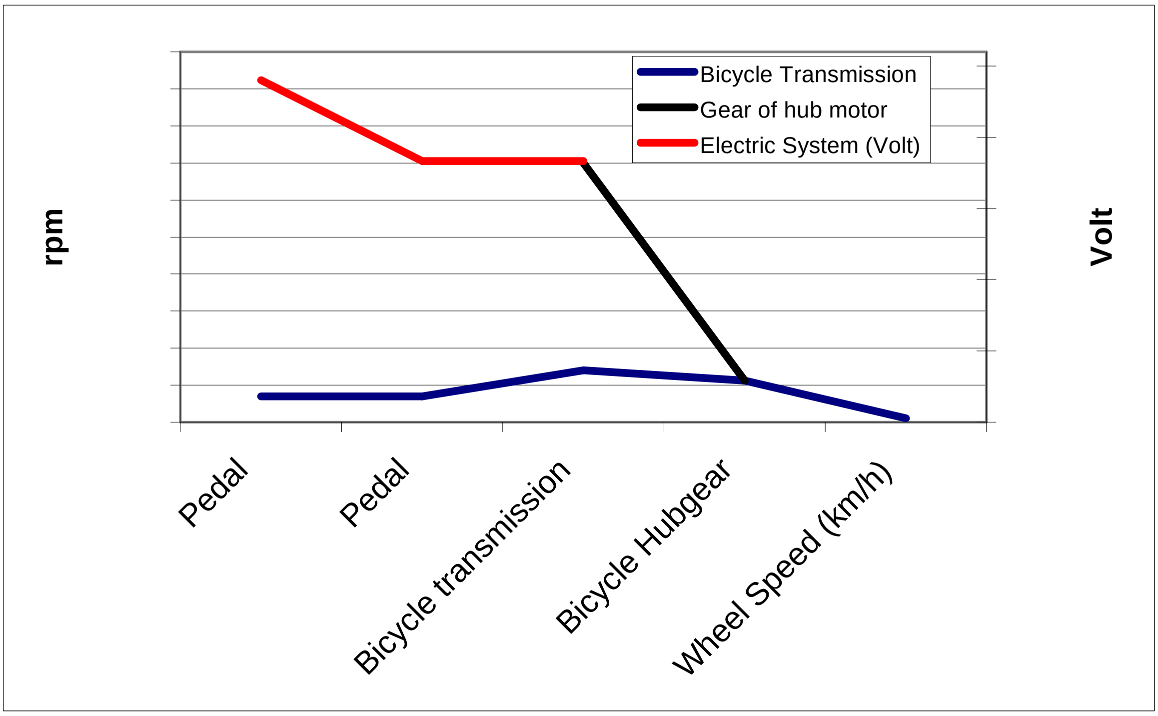


Fig 5b Schematic, qualitatively showing speed and voltage in an human electric hybrid drive with front wheel or rear wheel hub motor and traditional bicycle transmission.
Electric system (red): The battery voltage is reduced by the motor controller to set a certain motor speed.

A third principle for the mechanical addition of human and electric power is the setup using planetary gears by Michael Kutter (Kutter, 1990, 1993). Two axles of the planetary gear are driven by the human and the motor, and the third axle drives the wheel. By varying the speed of the electric motor in dependence of pedalling cadence, the effect of a continuously variable transmission results. The mechanical gears of the bicycle have to be changed only if the slope of the street changes by quite much. In the flats, while accelerating, no gear change is needed.

Ideally, the axle where the mechanical torques of human and motor are added should not experience speed ripple. Due to the fact that the chain drive is braked via the freewheel by the whole mass of rider and vehicle, the speed ripple of the wheels and the chain is usually small. But since the bipedal human produces a history of highly varying torque it is impossible to totally avoid drive torque ripple. If the motor is controlled such that the humans torque ripple is compensated at the wheel partially or fully, as a consequence the motor experiences torque ripple, too.

Definitively different from the series hybrid with purely electrical transmission of human power discussed below is, that in parallel hybrids, between human and machine, there is no energy storage device. In the mechanical world such storage devices are e.g. springs or flywheels. It is mechanically complicated to load such mechanical storages with energy, and to discharge energy from these devices. This explains why storage devices between human and machine do not exist in mechanical hybrid drives.

Ripple

On the chain, there are torque and cadence ripple due to the fact that the human works onto the crank as a bipedal “engine”. Consequently, the vehicle accelerates and decelerates somewhat, experiences speed ripple. This is less pronounced when using high gears, where the inertia apparent to the human at the pedals is high. But speed ripple is high when low gears are used.
If the total output torque at the wheels of the vehicle should be constant (so that the vehicle has no speed ripple), the motor would have to compensate the torque ripple of the human. In the extreme case, therefore the motor would have a torque ripple up to 100% of the average torque, but phase shifted by 180 degrees such as shown in Fig. 4 above!
In electrical systems varying currents lead to losses which can be much bigger than those associated with constant currents of the same time average. In parallel hybrids, losses would occur mainly in the battery, the motor controller and the motor due to the ripple in current which is associated with the ripple of torque.
If the controller of the parallel hybrid does not compensate for the torque ripple, then these losses do not exist or are small. However, the parallel hybrid vehicle will then suffer from drive torque and hence speed ripple. Torque ripple may negatively affect traction of the wheels on slippery surfaces.

At the Limits of Speed

To prevent that the cadence of the human or the frequency of the motor is forced to high values when going downhill, in PHEBs, overrunning clutches are used both between wheel and pedals and between wheel and motor.
Overrunning clutches are also helpful to decouple human and machine. In cases where the human pedals, but where the motor is off, an overrunning clutch prevents that the rotor of the motor is dragged along. Energetic losses associated with that process can be avoided.

Control of mechanically coupled Human Electric Hybrids

In mechanical cycles, the human uses the gear to adjust pedal speed and resistive torque such that they are acceptable or even comfortable. Pedal speed is held quite constant by changing the mechanical gear as soon as pedal speed is different from preferred cadence.
In e-bikes, the user controls the motor by operating a throttle manually. In pedelecs, based on some measured parameters, motor power is adjusted automatically. Parameters typically measured are pedal speed only in the simpler pedelecs, and pedalling torque also in the more advanced pedelecs.

Since an e-bike or a pedelec should help to reduce too high a torque load and corresponding strain on the riders legs and/or too high a power load and strain on the riders cardiovascular system, such a human electric hybrid should not only measure pedalling speed, but also measure torque. Only maximum torque of a person is correlated to speed, not torque between 0 and maximum torque. Since power is the product of speed and torque, both need to be known to derive power.

The place where the measurement is made determines if only pedal torque is measured, or the sum of pedal and motor torque. E.g. when measuring chain tension, then the sum of pedal and motor torque is measured in the case of a bottom bracket motor.
By measuring also the current of the motor and transforming the value into torque, from the sum of pedal and motor torque pedal torque can be computed.

In pedelecs, the motor controller automatically sets a certain motor power dependent on pedal speed, in some models also dependent on pedal torque.
Since human and electric machine are coupled mechanically, the user can influence the behaviour of the motor by changing gears in a certain way. Choosing e.g. a high gear usually provokes the motor to deliver more torque. This draws more current from the battery. When the motor controller detects a fast turning pedal, it usually assumes that the user does need less help and the motor reduces output power.

Adaptation to Riders and to the Driving State

In the case of a motor in or near the bottom bracket it is impossible to optimally adjust the motor to all potential users except when the gear ratio between motor and pedal or between motor or chain would be changed.
The motor is operated at a speed proportional to the pedalling speed of the human user. The huge dynamic range of electric motors over which they usually work at high efficiency can not be used. At low or high vehicle speeds, efficiency is reduced because the motor has to work with increased torque at the same, nearly constant speed. During hill climbing, pedalling speed usually reduces somewhat, so that the motor is forced to work at even higher load in order to deliver the same output power compared to the situation with higher cadence.

In hub motors, the electric motor works over the full speed and torque range. The losses can be minimized by choosing an optimal speed reduction gear ratio between motor and wheel. At medium speeds the motor works at highest efficiency, at higher and at lower speeds efficiency is lower, but can still be good.
Direct drive motors have, by definition, no speed reducing gear between motor and wheel. Consequently they operate sometimes at very low speeds and very high torques. High torques require high currents, which lead to losses in the motor as well as in the controller and the battery. Direct drive motors need to be heavier than motors with speed reduction gears in order to be capable to operate over the desired range of accelerations, speeds and slopes. Direct drive motors may make sense in parallel hybrid pedelecs which are mainly not used to climb longer hills at low speeds and which do not not pull very high loads such as trailers for kids or for post. Torque requirement is limited when in the flats, and hence current. At low currents, losses and thus efficiency drops are limited. However, for use in hilly areas direct drive motors are not optimal.

Vehicle speed is a parameter used to distinguish between driving states. The motor controller can decide to deliver power only when the vehicle is slowly moving, but not when it is moving fast. For legal reasons, in the EU pedelecs switch off the motor at 25 km/h.
That the EU law limits motor power of electric cycles to 250W independent of vehicle weight complicates the legal situation and is absolutely unnecessary.

Power depends on acceleration, slope and vehicle weight. A heavy postal pedelec needs much more power than a commuting pedelec to accelerate with a certain rate on a certain slope. For the same speed history, drive power is very different.
To maximize run time of the electric motor, electric power needs to be minimized since the batteries energy content (capacity) is limited. Every builder and user of a battery driven vehicle is highly interested to apply only as much power as required by the driving situation, but not more.
Therefore the power limit in the law about electric bicycles should be dropped.
Limiting speed and weight for various classes of electric cycles makes much more physical sense.

Electrical Coupling of Human and Machine

The human's mechanical output power can be converted into electric power by using a pedalled generator. This principle is called "electronic bicycle" by Harald Kutzke (Kutzke 1999), and "series hybrid" by Frank Jamerson (Jamerson 2009) and Andreas Fuchs (old name: Electr(on)ical transmission).
The addition of electric power and human power does not happen in the mechanical domain, but in the electrical domain. For example, the output of power electronics braking the pedalled generator can be in the form of a DC current (usually with some current ripple), which flows into the motor controller together with DC current from an other electrical source such as e.g. a battery. Only when there are no wheels taking power is the battery being charged.

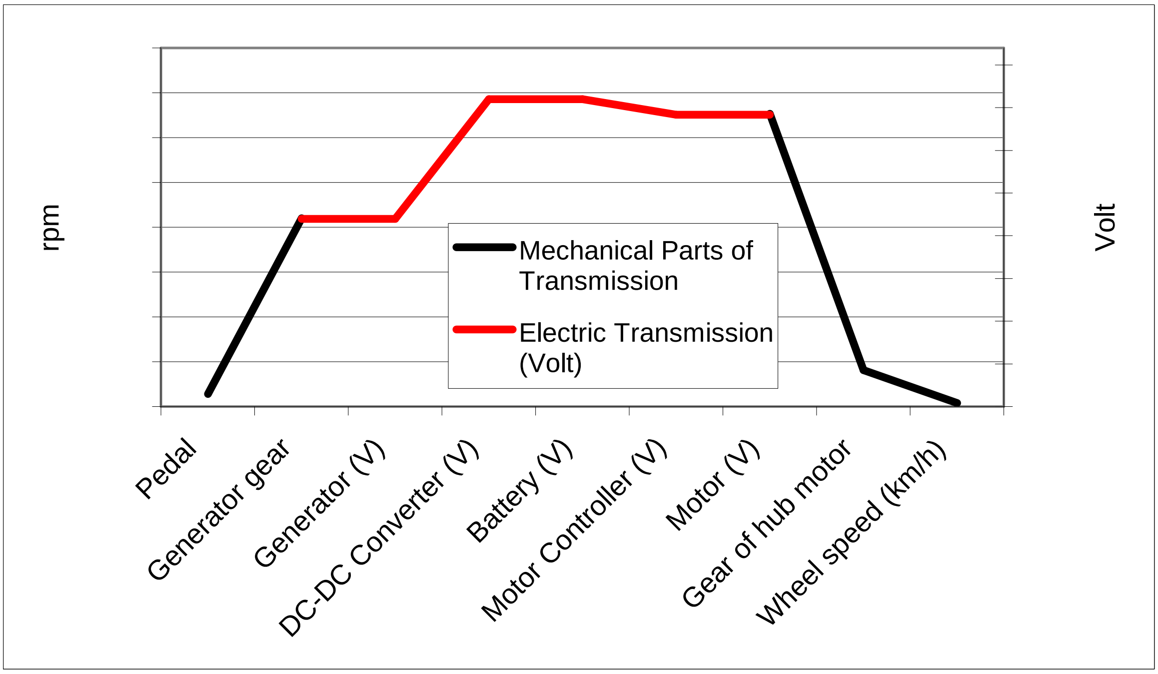


Fig. 6 Speed and voltage along the transmission of the series hybrid drive. Unlike the other hybrid drives, human and machine are mechanically decoupled due to the electric system (red) inbetween them, especially the battery.
When the wheels are running, the generator-current goes to the motors. When the vehicle is standing, the battery is being charged by the generator current.

Over more than the last decade, various vehicles with series hybrid drive have been prototyped in Berne, Switzerland (Fuchs, 2005, 2006).

Fig. 7a Peter Lacher on the EZ1 recumbent with the working model of the series hybrid (2003 / 2008).

Fig. 7b Prototype series hybrid drive mounted on an Anthrotech tricycle
(Fuchs, 2005).

Control is simpler than in mechanically coupled hybrids because human and machine are mechanically totally decoupled. Therefore, optimal loading of human as well as battery and electric motor is more easily possible.
Since there is no manually operated gear between motor and wheel, it is impossible for the rider to choose inappropriate gear ratios leading to increased energy use.

In the series hybrid, ripple due to the highly varying pedalling torque will be only on the generator current. If the motor controller controls the drive torque on the wheel(s) with a time constant in the order of pedalling period, that is, keeps it constant over about one pedalling period, then battery current will vary in such a way that the sum of generator and battery current is constant in time.

The ripple by pedalling will not be remarkable at the drive wheel. The series hybrid e-bike will therefore have a drive torque constant in time. On slippery surface, it is helpful when the drive wheel torque is constant rather than having a highly varying torque.

Discussion of Advantages and Disadvantages of the Drive Systems

Transmission Lines

The shortest transmission lines between the sources of torque – the human and the electric motor - and the wheel exist in the case of hub motors in the front or rear wheel. This is maximizes energetic efficiency.

More transmission elements are in line in the case of a bottom bracket motor and of a series hybrid, chainless transmission.

Bottom bracket motor: Electric power is transmitted via a long transmission line. The motor uses the transmission for human power, the traditional bicycle chain or transaxle, also. When the ratio of electric to human power is low, energetic efficiency is good (it then approaches the energetic efficiency of the bicycle transmission). However, if a lot of electric power is transmitted, the losses are considerable due to the length of the transmission line.
If the demand for drive power varies very fast such as in stop and go traffic, the gear ratio can not be adjusted as fast and as optimally as needed if the operation is manually done by the human. Therefore some designers think about automation of the mechanical bicycle gears.
In mechanical cycles, the rider adjusts the gears so that she or he feels comfortable. In case of a bottom bracket motor the motor is bound to the human power transmission (operated by the human), and can not vary speed according to the actual drive situation independently from the human. Therefore the motor can only vary torque to vary output power. The energetic losses associated with the variation of torque go with the square of the current (torque is proportional to current), and therefore losses are quadrupled if electric torque and power is doubled.
Energetic efficiency is low if electric to human power ratio is bigger than 1, and if the demand for electric power varies fast and over a big range.

Series hybrid: Human power is converted twice, in the generator from mechanical to electrical, and in the motor(s) from electrical to mechanical. In case electric power is low compared to human power, the energetic efficiency is limited to about 80% due to this double conversion between the mechanical and electrical domain (80% for a mechanically simple, eventually fully automated continuously variable transmission, CVT, is good!).
However, if the ratio of electric power to human power is bigger than 1 as when accelerating (especially in stop and go traffic), or when climbing, or when driving fast, efficiency is very good. The motor of a series hybrid cycle has to have a certain size since no chain is helping to accelerate and climb; bigger motors have higher efficiency than smaller motors as those in parallel hybrid cycles with chain.

Direct versus weak Coupling

The more directly human and machine are coupled, the more interference due to the different torque output patterns is possible. Interference leads to energetic losses.

One very big difference between the mechanical ways to couple human and machine and the electrical ways is, that in the latter case an energy storage is easily put between human and machine. The battery in a series hybrid can decouple human and machine nearly perfectly so that the influence of the one onto the other is neglectable. The human can pedal independently of the motor in an optimal way. And the motor can drive the wheel solely according to the demands by the drive task; the motor does see virtually nothing of the torque ripple by the human. The losses by interference are small, if existent.

Very direct mechanical coupling exists in the case of the bottom bracket motor. The legs of the pedalling human are comparably heavy and strong, and the electric motor and its controller basically have to act according to what the human does, have to “collaborate” as optimally as possible (the methods of “collaboration” of human and motor are defined by the control algorithms of the electric system, and in the future also by control algorithms of automated gears). A certain interference can hardly be avoided, and hence at least some energetic losses occur. In the case of a bottom bracket motor decoupling only happens when an overrunning clutch is freewheeling.

The least mechanical coupling exists in parallel hybrid cycles with front hub motors. The tires are sort of an elastic coupling between human and machine. Hence, interference is near to nothing and energetic losses due to interference are avoided. Overrunning clutches, mechanical ones or electronical ones, can avoid drag that would else slow down the cycle while coasting or while being pedal driven.

Energy Budget

The energy budget of a rider-vehicle-system is the difference between energy input and the energy losses due to all sorts of drag on rider and vehicle, in the drive train, and due to the interference of the hybridized drives, the human and the electric motor.
Energy input into the system is from the energy storages. One storage is the human; while pedalling, its biochemical energy reserves become depleted. The other storage is the battery which is decharged due to standby currents of the electric system and currents to feed the lights and the motor(s).

In case of the series hybrid the human can charge the battery by pedalling when the vehicle is standing. In a system like Bionx (direct drive hub motor with the possibility to recuperate energy) electrical loading of the human can only happen when the wheel is turning.
If there are overrunning clutches between wheel and motor, electrical braking is impossible. As a consequence, also charging of the battery while deccelerating or while going downhill is impossible. Series hybrids use an “electronical freewheel” which can easily be locked for recuperation.

Energy losses vary with speed and torque, that is, with power. Overall efficiency of the hybrid drive system decreases in the case of the bottom bracket motor when electric power is the dominant contribution to drive power, and in the case of the series hybrid system when human power is dominant. The energetic efficiency depends less on power in systems where the human power drive and the motor drive act in parallel onto the wheels via short transmission lines, but are decoupled, like in the case of hub motors.

If there are no manually operated gears between electric motor(s) and wheel(s) such as in the series hybrid and in the cycles with hub motors, unoptimal operation by the operator is impossible. The energy stored in the battery can be fully discharged via the motor excluding human influence. This guarantees sort of a “minimal electric range”.

Performance of the various Coupling-Methods

Unfortunately, the series hybrid drive system is not yet available on the market and therefore is not yet developed to a high standards. Fair benchmarking with parallel hybrid cycles is therefore not yet possible.

But performance measurements exist for the different types of parallel hybrid cycles with bottom bracket motor and hub motor. Series hybrid cycles are comparable to e-bikes and pedelecs with hub motors since series hybrids are equipped with such or with wheel suspension arms with built-in drives.

Extraenergy measured range and speed in 2002 both on flat and on sloped tracks.

We calculate the following “RS” (Range * Speed) values:

RS_f = (Range flat * Speed flat)

RS_s = (Range slope * Speed slope)

RSC_f = (Range flat * Speed flat) / Battery capacity

RSC_s = (Range slope * Speed slope) / Battery capacity

RSC_fs = (Range flat * Speed flat * Range slope * Speed slope) / Battery capacity

RSC-values are RS-values divided by battery capacity. The value of RSC_fs will be high if both in the flats and on the slopes the vehicle performs well, that is, goes far fast. If either in the flats or on the slopes a vehicle performs poorer, the RSC_fs value will be lower.

Drive class: Vehicles with the motor in the...	Number of vehicles	Remarks
Front wheel	4	
Bottom bracket	5	
Rear wheel	4	One vehicle has the planetary gear mixing system by Michael Kutter

Table 3 Statistics of the 2002 extraenergy tests, classes of drives.

The number of measured vehicles is low. So results have to be interpreted with care.

Drive class	RSC_f	RSC_fs
	Only flat	Flat & Slope
Front wheel	20.9 +/- 2.4	330 +/- 157
Bottom bracket	20.6 +/- 2.1	297 +/- 85
Rear wheel	20.3 +/- 3.1	186 +/- 82
Rear wheel, without the Kutter system	18.8 +/- 1.2	148 +/- 31

Table 4 RSC values for the different classes of drives.

RSC_f value, depending on range and speed in the flats, does not differ much for the different systems.
The RSC_fs value, which looks both at the performance in the flats and on the slopes, differ only a lot if one compares front wheel and bottom bracket drives with the rear wheel drive. The rear wheel drives (of the year 2002) perform poorest regarding range and speed in different situations. The front wheel drive systems go further faster both in the flats and on the slopes compared to bottom bracket drive systems.

This is not according to expectations: The promotors of the bottom bracket drives state that gears are favourable to adjust to different riding situations. But apparently front wheel hub motors are better capable to run optimally both in the flats and on the hills than are bottom bracket motors.

Also according to the extraenergy test results 2002, the front wheel drive systems reduce speed the least when riding on the slopes rather than on the hills. Second are the bottom bracket motors, and the rear wheel drives reduce speed most (compared to the speed in the flats) on hills. It is not absolutely clear why, but it could be that the motors are not designed to go on slopes and are at the limit with regards to climb-torque, yielding low speeds on hills and thus low RSC values.
If the Kutter system is not considered, then the performance of the e-cycles with rear wheel motor is even poorer compared to the front wheel and bottom bracket motor systems. Unfortunately, new data useful for RSC studies of recent e-cycles is missing; such data would be helpful in studying this fact deeper.

The fact that the deviation between the RSC_fs values is relatively bigger than the deviation of the RSC_f values suggests that the different kind of drive systems were optimized for operation in the flats; there, the different systems, hub motor and bottom bracket motor, perform all quite well. RSC_fs, that considers also performance on the slope, varies much more. It looks as though the designers did not care much to optimize also for performance on the slopes. This is rather strange because the big advantage of an e-bike or pedelec is to reduce load on the cyclist in situations which demand more power than riding in the flats. Extreme load situations happen when accelerating in the flats or on the slopes, and when climbing slopes.

Feasibility for different Applications

The extraenergy tests show that electric cycles with hub motor have good overall performance both in the flats and in the hills, and both in the bicycle mode and in the electric drive mode because both transmission lines are in parallel and are as short as technically possible, yielding minimal losses. The motors can be weak or strong. This setup can used for a wide spectrum of vehicles, from lightweight to heavy, from slow to fast.

Bottom bracket motor driven electric cycles are not ideal when the relative contribution by the electric drive becomes very significant compared to human power, because the transmission line from motor to wheel is of maximal length, leading to maximized losses. Probably these drives are not ideal on very heavy or very fast vehicles, but of course they work fine if human power is the dominant from of drive power.

Series hybrid drives have a long transmission line for human power. To operate series hybrid vehicles nearly like mechanical cycles, having absolutely no electric assist, does not make sense. However, mechanical decoupling of human and electrical machine allows to operate both independently and very dynamically and to minimize fatigue, to maximize the efficient use of electric power.
Therefore, for heavy and/or fast human electric hybrids like e.g. fast recumbent or upright pedelecs, velomobiles, cargo cycles or velotaxis, the series hybrid is well suited. Of course the absence of a chain is an advantage as such and is useful for many more cycle types such as e.g. folding cycles, or in pedal powered boats.

Conclusions

Various ways to couple human and electric machine are possible, using mechanical and electrical methods.

The data from performance measurements show that bottom bracket motor systems do not necessarily perform as well both in the flats and on slopes as do front wheel hub motors, although one would expect that, based on the fact that the motor can also use the mechanical gears of the human power transmission via chain. More research is needed to identify the real reasons for this effect.
One hypothesis of the author is, that since the motor is mechanically coupled to the pedals, it is not allowed to run freely (e.g. on a power hyperbola) according to the needs of the drive situation. So not the full dynamic range of the motor is used. The bottom bracket motor is loaded variable only in the dimension of torque, but not in the dimension of speed (rpm). Doubling electric drive power therefore leads to quadrupled energetic losses in bottom bracket motors.

Hub wheel motors perform well, at least if in the front wheel. More reasearch, maybe using younger e-cycle models than those from 2002, could eventually reveal the reasons why the rear wheel hub motors performed so poorly on the hills.

Final conclusions regarding the potential of the series hybrid drive system for dynamic riding and energetic efficiencies can not be made yet because no fully developed products exist at this moment.

References

Extraenergy Test 2002, www.extraenergy.org, 2002
Downloadable from:
http://www.extraenergy.org/main.php?language=de&category=products&id=467

Fuchs, Andreas. E-Management-Integration – Serie Hybrid E-Fahrrad-Antrieb. Final Report, Swiss Federal Agency of Energy, 2005
Downloadable from:
http://www.bfe.admin.ch/dokumentation/energieforschung/index.html?lang=fr&project=45975

Fuchs, Andreas. Series Hybrid Drive-System: Advantages for Velomobiles. Vélomobiles ou l'extension du domaine du cycliste, 8ème Journée d'Etude de la FUBicy, Vendredi 21 Avril 2006, in Amiens, France
Downloadable from:
http://www.hupi.org/HPeJ/0015/SeriesDriveHybridVelomobiles.pdf

Jamerson, Frank E., and Benjamin, Ed. Electric Bikes Worldwide Report 2009, www.ebwr.com 2009

Kutter, Michael.
1. Swiss patent application CH19900002074, 21.6.1990
2. VELOCITY – Elektrounterstützung für Velomobile. Proceedings of the First European Seminar on Velomobile Design, Technical University of Denmark, July 8th 1993. Editor: Carl Georg Rasmussen, 1993

Kutzke, Harald. The "Scooter Bike" as an example for an "Active Bicycle" with electric transmission. Proceedings of the 4th Velomobile Seminar 1999 "Assisted Human Powered Vehicles". www.futurebike.ch, 1999

di Prampero, Pietro E. Cycling on Earth, in space, on the Moon. Eur J Appl Physiol Vol. 82, p. 345 - 360, Springer 2000

Tetz, John. Up-Hill Assist. Proceedings of the 4th Velomobile Seminar 1999 "Assisted Human Powered Vehicles". www.futurebike.ch, 1999

Links

http://homepage.bluewin.ch/andreasfuchs/

http://www.bfe.admin.ch/dokumentation/energieforschung/index.html?lang=fr&project=45975

http://www.hupi.org/HPeJ/0015/0015.html

pedelec.com/taipei/lectures/pdf/pedelec-design.pdf

Light and Quiet Velomobiles with Foam Shell

Contribution by John Tetz
to 6th Seminar on Velomobile Design 16. – 17. Oktober 2009

The question I often get is why Zote Foam? My vehicle design is based on the power that average people can put out – not what the enthusiasts can deliver. I know the market isn't there just yet for average people so I applaud the efforts and interests of the enthusiasts for their support of a relative new industry that is leading us into a much more ecological local alternate transportation system..

The power range for average people who would be using the vehicle for local alternate transportation is in the range of 75 to 120 watts. We all know what weight does in acceleration and climbing. So it seems to me the challenge is to make a light vehicle for these people. Decent aerodynamics is also important.

There is no question that present commercial Velos are beautifully built. Solid, shinny, slick, big canopies, tower suspensions, sealed drive trains etc. But overall the vehicle is too car like. If you're a small person, or a woman, or old person (like me) you are stuck having to put out extra power to deal with this weight.

As light as composites may be the results are basically a bit too heavy for human powered vehicles for average people. It's not that composites are actually heavy but it gives a certain freedom in its use. Foam doesn't allow certain forms. You can't put any body weight on foam, therefore operations like getting in/out have to be done differently – generally resulting in a lighter vehicle. Canopies have to be smaller otherwise they become too floppy.

One solution is to add an electric assist system. Yes that does work, but at another increase in vehicle weight particularly if assist power is high. High initial vehicle weight means the assist will be used more continuously – which translates into more energy storage needed (battery) which means the assist weight cannot be low. Environmental issues are recycling costs at end of battery life, and electric power generation/distribution in various parts of the world. Here is a article about the E assists in China.
http://www.denverpost.com/nationworld/ci_12914468

Admittedly bikes and Vms are much lighter and more energy efficient than a car, but the challenge I am more interested in is to see how little overall energy can be use to transport people around. We humans have been using energy at a rate the Earth can not sustain. **Never has there been so many people putting out so much green house gas to be able to raise the temperature of the whole globe**.

Back to composite shells; their interior noise is quite high. Foam shells are very quiet – inside and out. I get criticized sometime by silently passing someone – it shocks them.

Other mis-perceptions about foam shells. Too flimsy, not enough crash protection.

I have had a few crashes over the years in foam shells – mostly in streamliners (the shell on my VM is only 3 years old). Some crashes were black ice in winter at night, rear wheel lock up, quick flat. On a high speed crash the vehicle rolled 360 degrees. On none of these crashes did I get hurt.

Also one day I was cruising along in a easy 20 mph, 32 kph in my streamliner, I quit pedaling to slow a bit to make a 90 degree right turn. There were a few 9 year old boys playing near the intersection. I leaned the bike over and decide to give them a thrill by coming close through the turn.

One of the boys thought I was going inside him so he stepped directly in front of me. BLAM – I knocked him down and the impact knocked me down. He got up, I pulled myself out of the streamliner. The Foam nose was collapsed in – like a crush zone. Neither of us got hurt. I pushed the nose back out and rode off. If this was a hard shell he would have been hit hard.

Another complaint; Foam surface is susceptible to scratches, gouging, and are hard to repair. Yes these are true. But how long does one keep a vehicle 5 years? Maybe 10 years? I got 10 years out of my Orange Foam Shell streamliner. I put stickers over the damaged areas. There is something impressive about a vehicle that has some hard won patina. An old vehicle eventually becomes worn and needs replacement. Also at the rate technology is advancing it may be worth owning an upgrade. Also could it come to a point where the shell costs could become low enough to replace just it and not the vehicle under it? Could the foam be ground up and reused to make a new shell?

But the biggest resistance to foam is the finish is not shiny. One of the most often asked question is what can be put on the surface to make it more shinny and even scratch resistance. Shinny seems to be a really big one. If it doesn't shine its not marketable. Many will pay the price of a heavier and more expensive vehicle to get shine. All these are sad comments on what is important. In essence this is saying that the vehicle is acting more like a status symbol and only second as ecological transportation.

Zote foam is one of the first foams used and may not be the ideal, but for now it has many of the requirements in making practical lightweight shells. Other foams may appear once the concept of foam is accepted – foams that may be more ideal for production, which could lower overall vehicle costs.

The following describe the philosophy and design of the trike/foamshell

TrikeFoamshellVMseminar1
TrikeFoamshellVMseminar2

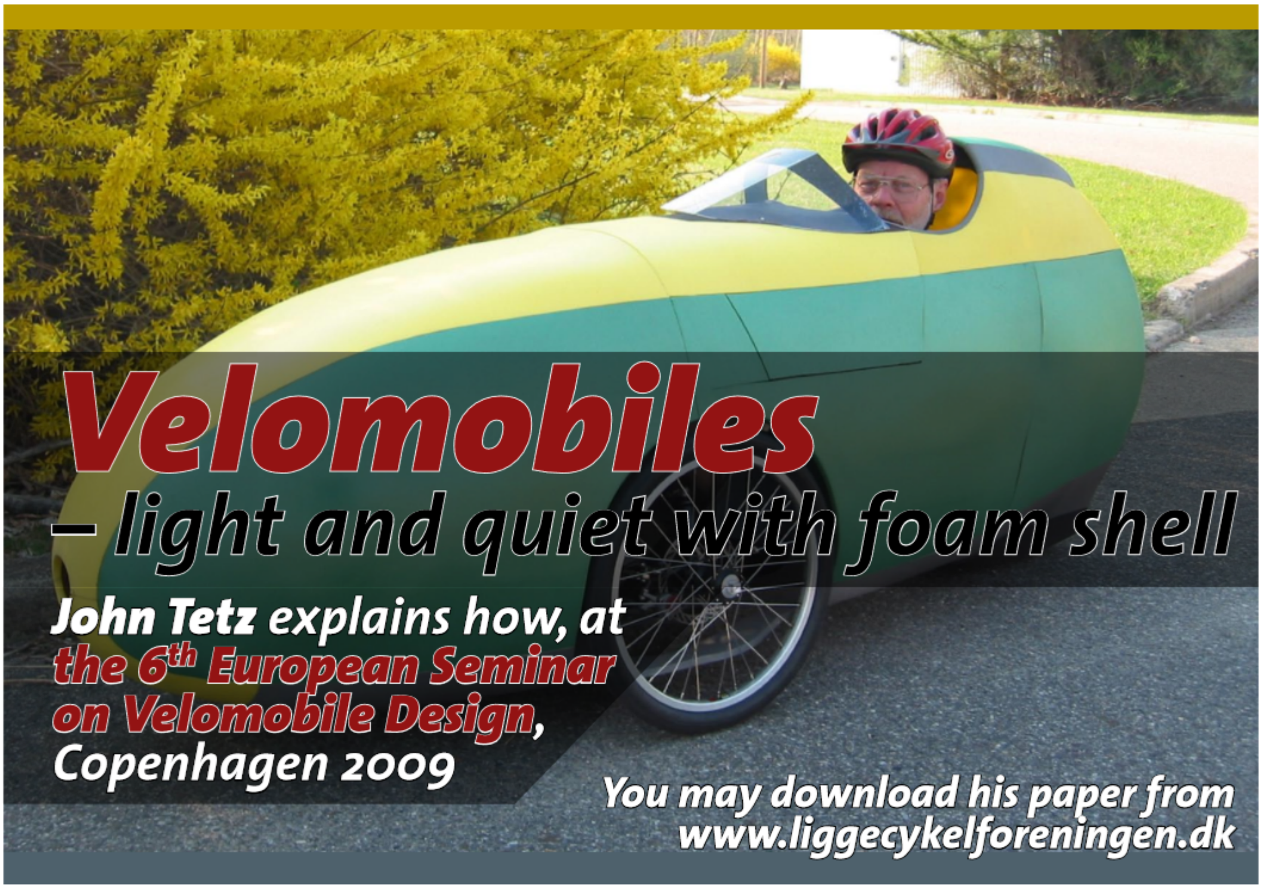
Foamshell Manual (on MARS web site which may not be in existence very much longer so you might want to copy and save the manual – its long and detailed)
http://www.recumbents.com/mars/pages/proj/tetz/manual/0intro.html

Ultra Light Electric Assist (ULEA)
http://www.recumbents.com/mars/tetz/E-Assist.htm

Current Limiter Circuit
http://www.recumbents.com/mars/tetz/Current_Limiter_Circuit.htm

An additional fine tuning of the circuitry is Spike suppression. It's on the WISIL site
http://www.recumbents.com/home.asp?URL=wisil/main.asp
Click on Projects, then Electric Hybrid Project Page,
Then click on Spike Reduction.
The above two articles are also on the WISILE site.

John Tetz
jgtetz@msn.com



John Tetz: Trike Foamshell Velomobile 1

This article describes the design philosophy of a tadpole trike (two wheels in front, one drive wheel behind) with a foamshell wrapped around it. This design represents one approach of many possibilities that are out there.

The trike can be easily removed/installed (in about 10 minutes) from the shell and used unfaired, so you have essentially two vehicles. I find I sometime use the unfaired version for the milder part of the year because it's simpler (easier to get to the panniers, easier getting on/off, smaller vehicle to park). I use the shell for the most part of the year specially when it gets cold so I can ride through the winter to run my errands. I also use one of my shelled vehicles at night because of the additional visibility to the cars.

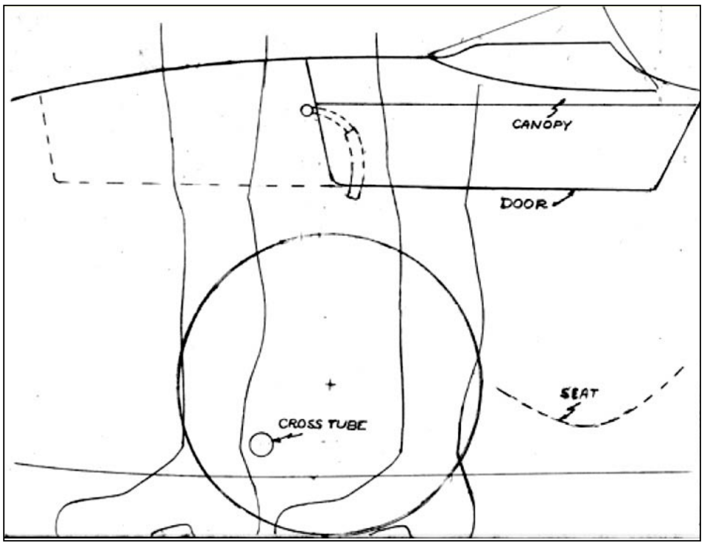
Why foam? Mainly for extreme **weight savings**. Average healthy human power capability is limited to a range of around 75 watts to a max of 150 watts, but only for a short time at the 0.2 hp/150 watt range. The challenge is to build a vehicle that works well in combination with that power capability.

Most European velomobiles weigh about 70-80 lbs/35 kg and are beautifully made machines. But not all of us need to pay in rider effort for that kind of elegance. A foamshell velomobile could weigh in the low **40 lb/18 kg** range, and possibly less, which of course translates into a difference in effort from the rider when climbing hills, but felt especially during acceleration, and acceleration happens over and over again during a ride. I can also make my vehicles lighter because I weigh 158 pounds and my max power is 150 watts. No need to power a vehicle designed to carry a 250 pound rider (advantage of building your own until commercial companies accommodate smaller less powerful people).

One of the first issues to be solved for a shelled vehicle is **climbing in/out**. Without a shell, the traditional way to climb onboard a tadpole trike is to stand **in front of the cross tube** that supports the front end, and lower yourself down onto the seat. But this method is not practical when the vehicle has a shell wrapped around it. Solving the in/out problem is one of the major challenges with fully faired vehicles, and particularly with foam.

Stepping in front of the cross tube means the canopy or whatever opening is used has to be very long (or a swing nose section which is floppy). Long canopy surfaces having to match the main shell create a tolerance and attachment problem. A large canopy would have to be made stronger, therefore heavy. On any shell material, a large cutout would weaken the main shell structure, and more so with foam.

The following drawing shows a partial side view of a shell with a rider standing in front of and in back of the cross tube. This is the type of canopy system I have used for many years on all my streamliners. Note the resulting increase in length of the canopy (dotted lines) for the forward position.



The first design requirement for this trike is that the rider be able to **climb in behind the cross tube**. This means there must be around 12 inches between the cross tube and the leading edge of the seat. But the seat cannot be moved rearward without moving the center of gravity to the rear, causing the trike to be very tippy on hard cornering. One inch back from a standard position can cause a serious loss of cornering stability.

By the third cross tube version I built, I was able to move the center section of the cross tube forward enough to give the necessary foot room, yet leaving the head tubes in their proper location. The cross tube is made in three sections: an open V-shaped main tube and two semi-vertical tubes which connect to the head tubes. The critical distance from the seat to the axles is about the same as on a traditional tadpole trike, thereby keeping the Cg in its proper location. Here is a top view (following page, top) looking down the handlebar post (also shows seat-to-cross tube clearance about 12 inches, 30.5 cm).

Another way to maintain cornering stability is to place the **seat** bottom as **low** as possible. This seat bottom is 7 inches above the ground. This also works well for the shell.

Another major design change is **above seat handlebars**.

Why above seat handlebars? How do you get in/out of a shelled vehicle? A popular method is by using the shell as support while lowering yourself into the vehicle. That means the shell has to be strong enough to support that much weight, therefore heavy. Foamshells cannot be leaned on, so another system is needed.

Without a shell, it is natural to get on/off in front of the cross tube, but the handlebars have to be out of the way, off to the side, therefore under seat handlebars. But when a vehicle is placed inside a shell, all kinds of new problems have to be solved.

Climbing in or out is where the above seat handlebars work very well. The handlebars are used for balance while lifting your right leg up over the edge of the door cutout on the shell, then lifting your left leg in, and lowering yourself to the seat, all while applying the handlebar brakes so the vehicle doesn't roll.

How do you lift yourself up off a seat that is so low to the ground? Easy – grab the handlebars and pull yourself up. And again, use the handlebars for balance when getting out.

Cross tube clearance: Once you are sitting on the seat, getting your feet up and over the cross tube and onto the pedals requires that your feet have to be raised above the cross tube. So to reduce that height, the cross tube is mounted **below the main frame tube**. It's quite difficult to use leg muscles to pull your leg back and lift your leg over the cross tube while sitting on a seat 7 inches above the ground (because your leg is folded up). This is accomplished by grabbing your ankle and momentarily pulling back while lifting your leg. For me this has become a quick, totally automatic reaction. And yes, a bulky, less flexible body would take a bit longer to adjust.

But the payback is in powering a 40 pound rather than a 75 pound vehicle mile after mile.

How do you **walk a trike in a shell** if the handlebars are in the traditional under seat position down low inside a shell? In my area there are some bridges across which (by law) you have to walk your vehicle. Bending over far enough to steer under seat handlebars and walk alongside a shell would be very difficult. Trike shell widths are quite fat, meaning the walker has to bend over further than a with bike streamliner. With above seat handlebars, simply open the canopy partially, reach in, push and steer with one hand – and casually walk alongside. Joystick vehicles can be steered OK, but you can't push the vehicle forward with the joystick, so another hand is needed to push on the shell. Not as practical to do as with foam.

In order for me to park directly in front of some stores where I shop, I often have to **lift the vehicle** over a 6 inch curb, and when I leave I need to turn the vehicle around 180 degrees in a small space. You can't do this with under seat handlebars. But you can grab the above seat handlebars with the left hand and the seat vent hole at the back of the seat with the right hand to lift the trike, another reason for foam and a lightweight vehicle.

And finally, a foamshell needs **upper support** in the area in front of the handlebars. I added an aluminum tube running from the boom near the bottom bracket to near the top of the handlebar post. A Y-support is attached at the top of this bar near the handlebars.

The **tail section** of the shell can be removed. The first reason is for getting the trike in/out of the shell (after the front wheels are removed). The flexibility of the foam allows the shell to be spread enough to remove the trike for riding unfaired and for maintenance. But another reason is to simplify fixing a rear flat. The removable tail also reduces the length of the vehicle so it can be stored or parked in a smaller area, and be transported in a smaller car (like my Honda Civic Wagon). One other reason is that Zotefoam sheets are limited to 80 inch lengths.

On a **unfaired** trike, there are **advantages** to the above seat handlebars:

1) The arms are inline with the airflow, a **more aerodynamic** position. With under seat handle bars, the arms are alongside the body, increasing the frontal area by more than 6 inches. The effective frontal area here is more than the physical width of the arms because the air has to go way around, also creating a big drag wake behind. I easily out coast trikes with arms along side their bodies. CdA measurements I have made are 2.8 sqft, 0.26 sqm vs 3.4 sq ft, 0.3 sqm.

And another advantage which I realize is there can be **more rider cooling** due to the airflow in the armpit area, where there are quite a few blood vessels and sweat glands.

2) **Mirrors** can be mounted on above seat handlebars well within the forward field of view. Handlebar mirrors of course do not work in the shell, so shell mirrors are necessary, but these can be small because they are close to your eyes and give a decent rear view.

3) To pick up and **carry** the bare trike, grab the handlebar post half way down, tip the trike on its side, and grab the frame behind the seat – a balanced position. Tipping a trike is often necessary to get it through narrow home doorways.

Are there any **disadvantages** to above seat handlebars? Yes, of course. If one of the front wheels drops in a hole, the trike momentarily rotates, and so do the handlebars. No big deal. But, say, the right wheel goes down at the same time the left wheel goes up over a bump. Then the handlebars rotate much harder to the side. Going over railroad tracks is a trip, with small but violent high speed vibrations. I lighten the grip when going over railroad tracks. That is about the worst it gets. Suspension reduces this vibration.

Another problem, generally with all above seat handlebars, is there is less clearance for knees for a wider range of rider sizes. I have found that a reasonably wide range of riders fit without knee interference. With all the advantages of above seat handlebars, I feel they are worth it.

John Tetz

John Tetz: Trike Foamshell Velomobile 2

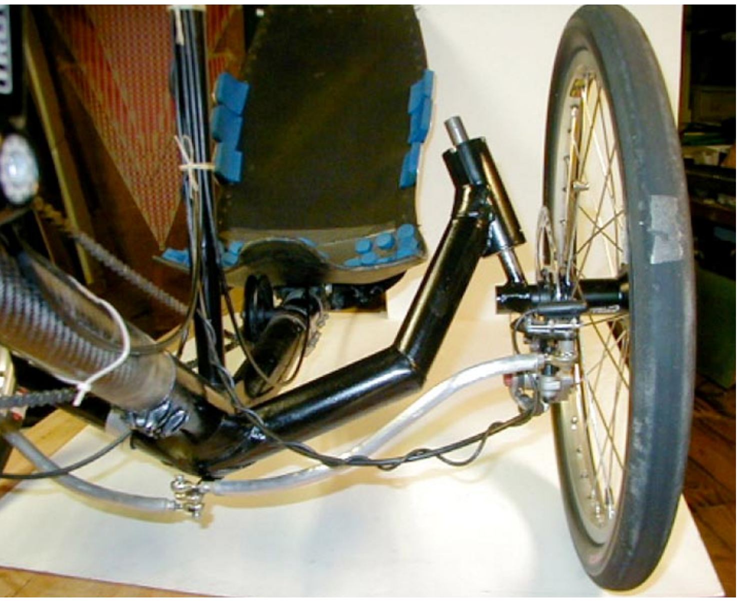
Another design change I made from the traditional tadpole trike was to **raise the bottom bracket height** so the heels can clear the bottom of the shell. The shell ground clearance is dictated by the lowest part of the trike frame. The holes for the feet are behind the cross tube further back from the nose. This helps maintain cleaner airflow along a longer distance. The airflow might even be laminar for a part of that distance because of the shape.

I like a BB to seat height of about 9 inches, 23 cm so most of my vehicles have this ratio. My leg muscles don't have the readjust going from one vehicle to the next.

In order to see over the top of my toes, the **seat back** is around **45 degrees** (which I happen to like for a road vehicle – gives the ability to turn your head around to check for traffic).

The **tie rods** are in front of the king pins, rather than in the more normal rear position (except for Greenspeeds). This is to get the tie rods away from your feet when climbing on/off. My thanks to Peter Eland; I would not have been able to find this position without his trike steering spreadsheets:
www.eland.org.uk/steering.html

Front suspension: I eventually developed a compact head tube suspension system. The ride was simply too rough without it since a trike is bound to hit more bumps and holes than a bike. Because the foamshell is not as stiff as a composite shell, it jiggled annoyingly left and right over bumps (no such left/right jiggle problems on a bike streamliner). Without the shell, the ride didn't seem as rough, but inside the shell the jiggle gave the perception the ride was rougher. Because most of a trike frame is low, the upper shell support system is less stiff, which aggravates the jiggle problem.



John Tetz

As you can see in the photo, the head tube is a bit larger in diameter so a spring can fit inside. The internal parts layout consists of a **lower bronze bushing**, allowing the kingpin to slide up and down, plus turn. At the top there is a ball bearing with a **center bronze bushing**, allowing the kingpin to turn and slide. A ball bearing takes the vertical suspension load of the vehicle plus a bit of the side load from the angled head tube. At this high load position the bearing reduces steering stiction more than a simple bushing would, so that smooth micro-steering corrections can be made.

On rare occasions the system bottoms out on very deep holes, so I use a small **external rubber bumper**. A smaller diameter spring can also be placed inside the larger main spring. This spring can be used for heavier riders.

There is **no damping**. Between the small suspension movement of 0.9 inches, 23 mm, plus the drag on the bronze bushings, I have not experienced any wheel hopping. This is a relatively lightweight suspension – it adds just over **1 pound, .45 kg**, total for the pair over a non-suspended head tube system.

You will also note in the photo that the **tie rods** are below the center of the main frame and go up to the king pin steering arms at an angle. This turns out to be ideal in the fact that they are completely **out of the way** when the rider is getting on or off the trike.

But the main reason for this important tie rod angle is to **reduce toe changes vs suspension movement**. A more vertical head tube would be ideal. This would reduce the amount of horizontal wheel movement during suspension travel. But because the disc brake rotor would come close to running into the head tube at maximum suspension compression, this is the steepest that the head tube can be. Drum brakes would allow a steeper angle. The head tube angle also has to be steep enough for the rider's legs clear the top edge of the head tubes (which are a bit higher than regular head tubes), otherwise the track width would have to be increased. I wouldn't want to go wider because at 29 inches, 74 cm, max width at the wheel hub centers, the trike clears most doorways (In the US). Present track is 27.5 inches 755 cm.

All the effort to design and build this head tube **suspension pays off** – it works very well. The ride is noticeably plusher. It takes out those hard hits, plus it reduces the side-to-side trike rotation when individual wheels hit bumps or holes. With these changes I'm pleasantly amazed that the handlebars do not vibrate across bumps such as railroad tracks anymore. I find I have stopped spending time looking carefully at the road surfaces in an attempt to minimize the road shocks (what a relief). Suspension is definitely worth the extra 1 pound.

Having **fat tires** and running them softer helps take out the high frequency vibrations over marbled road surfaces, yet the Crr doesn't climb enough to be a big problem:

I find that measured rolling resistance of fat tires to be as low, and quite often lower, than some narrow tires. Narrow tires have to be run at higher pressure, which means a harsher ride even with suspension. Tire loads when cornering are very high on trikes, another reason for fat tires. They seem to complain less than the narrow tires, and are also less prone to pinch flats.

However this type of suspension does have its own **quirks**. If the wheels are not rotating, such as when getting off the vehicle, the suspension doesn't slide until the rider's weight is off (so the wheels can move outward). This results in a surge of frame motion of around 0.4 inch. With the wheels rotating, the suspension and tires can easily move in or outward smoothly without that surge. The amount of horizontal movement (+/- 3/16 inch max suspension movement) does not seem to affect Crr noticeably, but I have not made rough road Crr measurements to verify this. This vehicle does roll right along – it out-coasts the few commercial trikes I have compared it to – but this is partially due to the straight-out arm position.

I built a lightweight small movement (1 inch , 2.54 cm) **rear wheel suspension** unit with rubber bumpers. There is no damping here and less swing arm bearing drag, so on some occasions the rear wheel can momentarily hop just a bit. I'm not sure what to do about this – might have to investigate a different suspension design. I hate to keep adding a pound here and a pound there; it easily adds up to a heavy vehicle.

Yet this suspension unit does a reasonably good job of taking out the hard hits, hits that would otherwise go directly into the back of the hardshell seat, and therefore into the rider. Most uncomfortable. This particular layout allows a structural support (carbon rod) to a lightweight (all-carbon) luggage rack, to which the tail of the shell is attached, so the rack stability is quite important. And yes, I do get a bit of pogo suspension movement at very high pedal pressures, which my body doesn't allow me to do very long – minimized by round pedaling.

The shell and the vehicle has to be designed together. All of the above design requirements for the trike have to be considered simultaneously along with the design considerations of the shell – challenging compromises. The shape was chosen for a **low CdA**. Many of my errands require going some distance, so reduced rider effort and decent speed are two of the requirements high on the list. This results in a smaller tail cargo area than on other velomobiles. However this satisfies my cargo needs. Total vehicle weight is a bit over **40 pounds** (trike 33 pounds, shell about 7 pounds). CdA is around 1.2 sq ft 0.11 sqm.

See my **Zotefoam Manual** on how to fabricate the shell; all new techniques were developed, using only a male mold:
www.recumbents.com/mars/pages/proj/tetz/manual/0intro.html

The basic **foil shape** (top view) is dictated mostly by the length of the nose to the wheels at the hubs, the widest part of the shell, then a slow contraction to the riders shoulder clearance, and finally, a straight rate of contraction to the end of the tail. The tail is cut off to house a taillight and reflector material, and also to reduce overall length for parking and transporting – and a small reduction in weight. However, less tail area I believe aggravates crosswind instability. The popular feeling is the tail area should balance the nose area, which is hard to do with a long nose (wheels far back from the nose) so to compensate, the turtle deck is quite high in an attempt to gain a little balance.

Side view: The toe/heel clearances and location of the trike within the shell have a large influence on the shape of the nose. The top view nose length affects the shape and rate of upsweep to clear the toes/heels. A compromise has to be made between the top view and side view nose shapes. The side view is surprisingly close to my **VFS/Vacuum Foamshell** with its upswept nose (its front wheel is further forward and totally inside the shell):

www.recumbents.com/mars/pages/proj/tetz/VFS/projtetzVFS12finished.html

www.recumbents.com/mars/pages/proj/tetz/VFS/projtetzVFS00intro.html

This **upswept** nose has been used on many vehicles, including Varnas, super-mileage vehicles, solar cars, and others. The theory is that the space between the shell bottom and ground forms a slot which accelerates the air, creating negative lift. Any lift is induced drag. And the much flatter bottom area of a trike shell aggravates this effect. The lift from an upswept nose can help cancel that negative lift. This shaped nose may also pull some of the turbulence out from under the bottom of the shell. Maintaining smooth flow along the bottom of the nose area helps keep the buildup of turbulence smaller for a longer distance (my foot holes are further back, in front of the seat, which helps keep the bottom air cleaner longer).

Because of the larger shell width up front, pedal Q is not an issue.

I have chosen an **open cockpit** so the rider can hear traffic easily. This also makes the shell lighter, with the added benefit of less fogging of the windshield. The windshield is narrow enough I can see around it. If conditions are tough I can easily lower the windshield on the fly when it fogs and when it is hot.
I often flip open the canopy when climbing a long hill to get more cooling air. The very light small canopy simply hangs off the side of the shell, no restraints needed.

Mounting points are also similar to my streamliners – a Y-connection to hold the area forward of the canopy up and out, attached to the tube from the handlebar to the boom. In addition a carbon tube from the bottom bracket to a contact point on the inside of the nose on the fiberglass nose, (explained in my **Zotefoam Manual** under the ***Mold*** section). There are two upper connections at the top of the back of the seat and a tail support at the end of the luggage rack. Also the bottom attached to the main frame in the foot hole area and along the bottom of the frame with Velcro. There is a carbon tube going from the head tubes up to the spray shields. These help prevent left/right movement of the shell in the area of the cutout for the wheels.

It takes about 10 minutes to get the trike in/out of the foamshell. The front wheels need to be removed (I have outside removable axles).

Here is a view with the inner wheel spats. They are made from thin HD 80 Zote foam and are held on with Velcro.

Horizontal bottom bracket: To accommodate different size riders, I built a BB that can be adjusted horizontally. With a standard BB mounted on the end of an angled boom, any adjustment affects toe or heel clearances in the nose of the shell, where the clearances to the shell are closing in fast.

It consists of a square aluminum tube that slides inside a U-shaped clamp. The adjustment can be reached by the rider leaning forward on the seat. This adds another pound to the vehicle.

The best method of **storing the shell** when using the trike unfaired is to suspend it as it was hung while building it. That way the shell will take on a normal

shape without distortion. If left on the floor, it will expand in width and eventually take on a set. The tail and turtledeck are stored inside the shell. The dimensions for storage and shipping are 80 inches/203 cm long, 28 inches/71 cm high, and 27 inches/27 cm wide.

Construction time line of the overall project: Drawings made in the winter 2004. Started to build the trike in 5/04; this is my first trike and I had lots to learn (much more than a bike). The first version was on the road in 8/04. Trike version changes 2, 3 and 4 up to 1/05. Started the mold construction in 1/05; shell on the road in 3/05. Continued trike version changes 5 and 6. No real changes to 09.

Future projects: Forward/back seat adjustability (presently the shell is attached to the seat back, which makes moving the seat for different size riders essentially impractical). I did add 2 NACA hand vents (already have a removable nose vent), and a retractable 3 watt LED night lighting system mounted high on the nose of the shell. I also added a lightweight 5 pound, 2.3 kg 100-watt electric uphill assist for local use.

John Tetz

12 kg velomobile made by Meufel-technology

Contribution of Harald Winkler
to 6th Seminar on Velomobile Design 16. – 17. Oktober 2009

PE-Foam, carbon fibre and sophisticated design make it possible to build a fully enclosed three-wheeled vehicle weighing less than 12 kg.

Now what's so special about this design? To find out, let's have a look inside that craft. There we see: Almost nothing! No central framework is spreading across the little cabin, the room enclosed by the foamshell is mostly empty, thus offering all its space to the driver and the luggage, which finds its place behind the drivers seat, beneath the rear wheels. Two beams, each at one side of the cabin, split at the rear to take up the rear wheels, connected by the drivers seat, form the carrying structure and serve as a stable suspension for the foamshell at the same time. It's all made of carbon with a styrofoam core. The common crankset and bottom bracket is replaced by a crankshaft (welded steel tube) suspended on both sides with self-aligning ball bearings (industrial type 108 TV, weighing only 14 gr. each).
The chainwheel is on the left side of the crankshaft, thus allowing to lead the chain besides the driver straight and direct to the left rear wheel, avoiding the mechanical losses that usually appear at the turn- around sprocket. A cardan joint connects handle bars and frontwheel and allows it to turn around a full 180°. Therefore the turning circle is the smallest possible and heavy cornering is great fun. The cardan joint consists of four adjustable aluminium cones fitted in a flat POM cylinder. It's also acting as a steering damper. If wear should occur after al long time of use, it can always be properly readjusted. A low profile carbon seat offers a comfortable ground clearance of 6 cm, sufficient even for non asphalted gravel walks, although the seat height is as low as 9 cm. Travelling so low means excellent road holding without needing any complicated spring-suspension system. The foamshell is hinged at the front and can be lifted up easily for getting in and out of the vehicle. Slots flap open when you need to give hand signs. It takes only a few seconds to remove the shell completely and to fix it again, no tools required to do this. The canopy offers a 360° panorama look even when closed and can be slid open as known from classic aircraft. Luggage can be easily loaded. Its weight doesn't affect much the lightweight frame structure, because its rested directly at the rear axles.

Technical data

215 cm long, 68 cm wide, 173 cm wheelbase, 97 cm high.
7 speed derailleur gear.
Weights:
Frame and seat unit: 3400 gr. / Frontwheel 16 ": 630 gr. / Rearwheel 20" left: 1470 gr. / Rearwheel 20" right: 830 gr. / crankshaft and pedals: 1200 gr. / chain: 650 gr. / Brakes: 280 gr. / fork: 350 gr. / Derailleur: 250 gr. / street legal light, dynamo and reflectors: 290 gr. / Foamshell and canopy: 1210 gr. / Wheelcases: 320 gr. / Steering: 590 gr.
Total weight in reality: 11,6 kg
Note that another 150 gr. at least could be easily saved if those bloody expensive lightweight chains would be used.

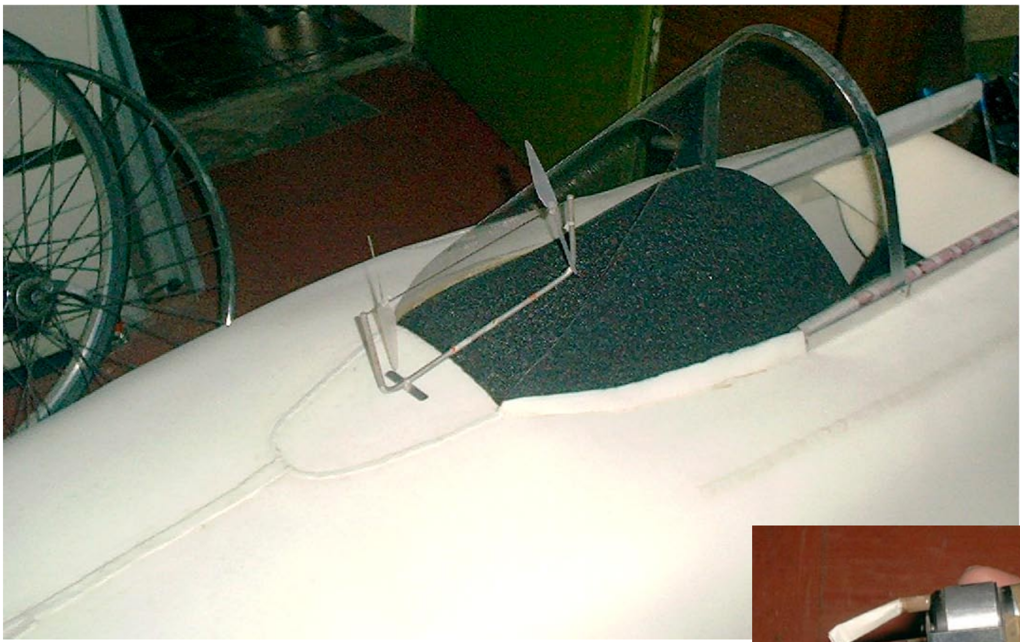
Something about the MEUFL-technology

The material is a PE-foam with a density of about 30 kg/ m³ and enormous plasticity. Tensile strength is at least 0,18 N/mm². The plain foam sheets are warped to a three-dimensional structure by joining their round-cut edges together, thus causing a shortening of this edges. The trick is to find the right cut. Up to now there is no way of exact calculation, you got to have a feeling for it. For more vaulting, the sheet can also be warmed in the middle with a hot-air fan and then carefully be stretched in just that area. Cutting can be done with a ordinary pair of scissors, a sharp knife or a electrically heated, hot wire. The same sort of wire can also be used to weld the edges together. The only difference is that you have to push the sheets together when they are past the wire instead of tearing them apart. Hot air may be used for welding as well. A special micro-fan, with a jet as small as 2.5 mm diameter has recently been designed for that purpose, allowing very precise work, but also ordinary big fans are used for welding of bigger areas. In the early days of MEUFL-technology foam sheets were connected with a pretty smelly glue called "Pattex", but welded connections turned out to have much higher durability, due to the UV-sensibility of the glue.

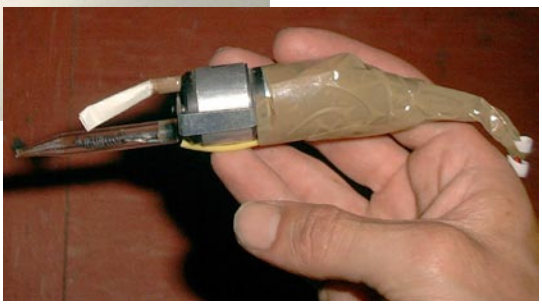
A foam shell can be used for many years. It is unbreakable, but rather sensitive to scratches and cuts, that will do a remarkable change to its look over the years. The best way to deal with this is to accept used-look as cool and stylish, a point of view that has been well established with jeans-fashion for quite a long time now. Foam is available in different colours, but white is to prefer, because of its good visibility and because it is the only colour that even looks better when bleached by the sunlight.

You need no special equipment like moulds or models to apply MEUFL-technology, what means extremely reduced costs when you are building just a single prototype. However, if you want to build great numbers of foam shells at an industrial scale, you should prefer a deep-drawing process like John Tetz does. Although this requires a mould and a heating chamber, it quickly pays off in serial production because deep-drawing is so much faster than traditional hand-meufling. Deep-drawn foam shells tend to be a little heavier then hand-meufled ones, because with deep-drawing it is hard to keep the thickness of the foam constant over the whole of the profile and therefor thicker foam and foam of higher density and stiffness has to be used. Despite this, deep-drawing offers the great chance to produce big series of very cheap foam shells, that are still by far more lightweight than any expensive high-tech hard shell could ever be.

Latest news:
Just a few hours ago, in the evening of 28 July 09, the brand-new MEUFL Prepeller has been tested successfully for the very first time! This device, a combination of a propeller and a repeller mounted on a common shaft, so that the propeller is driven by the repeller exposed to the airstream, keeps the airstream –and the rain coming along with it– off the drivers face like a virtual windscreen. Without any need for being wiped. Weight is less then 20 gr.



MEUFL Prepeller



MEUFL micro-fan

Velomobiles and their Diversification:

An Approach towards Greater Acceptance in Societies?

6th European Seminar on Velomobile Design

Copenhagen, October 2009

Heike Bunte

Structure

1. Introduction

The diversification of products in our societies is like a Janus face. On the one hand it seems that pluralisation brings 'bright colours' and 'great choices' for our lives, and on the other hand it seems that all these 'things' create more complexity than we are able to handle. Sometimes diversity of products seems rather a hurdle than a relief. In addition, we live in the age of extremes (Hobsbawm 2006), post-modernity or liquid modernity (Baumann 2008). A unique sign of this age is social and technical acceleration (Rosa 2005), in which individuals must design their own life rather than count on stable social structures and social governmental policies. Furthermore, the leading key word in our societies is individualisation (Degele/Dries 2005; Kippele 1998), which requires a permanent new concept and classification of the "self". With regard to individualisation, the aspect of diversification functions as a means to an end. Also, with diversification the growing aspect of complexity comes into societies which the individual has to manage.

The 'velomobile system' is the perfect response to the age of individualisation. Not only the wide range of models offer all different types of aspects of individualism (the everyday cyclist, the family type, the "man" of pleasure, the fitness, racing type etc.), even the guarantee of spacious isolation or, in other words, perfect private atmosphere is given. Moreover, the range of models generates more uncertainty than certainty because the customer got lost towards diversity. And if diversification is the key code to attract the individual, how does a producer reduce the complexity of the situation? Currently, the identification of a growth in counselling in knowledge-societies is remarkable (Faust 2006: 286). Furthermore, counselling is a social phenomenon the situation of which itself is crucial because of an asymmetric constellation between two persons (Alemann 1996: 16 f.). Finally, the paper deals with the social concept of counselling under the aspect that velomobile producers accept the asymmetry of knowledge between producers and customers instead of playing an active role-taking.

2. Individualisation and diversification as a topic for societies

Individualisation

The discussion about individualisation or the individual is on the one hand formed by several key words as ‘Ich Gewinner’ (I-Winner), ‘Ichlinge’ (lot’s of I’s) (Keupp 2003: 297), and on the other hand individuals are described as ‘players’, ‘flaneurs’ and ‘tourists’ (Baumann 1997) who have to face a constant situation of risk taking, uncertainty and social de-embeddedness. Furthermore, individualisation is a dynamic process. Therefore, not only negative but also positive actions can be identified. Moreover, the relation between the individual and the society can be described as a constant differential. The ambivalent relation produces ‘winners and loosers of individualisation’ in postmodernism (Baumann ebd.). Georg Simmel (1992) as one of the classical sociologists demonstrates the challenges of society towards upcoming forces of individualisation as well as the description of individual perspectives, i.e. social and technical acceleration[1]. The situation of individualisation causes ‘Self Care’ (Foucault) and non-constant biographical developments (Simmel ebd.). The identification of the Care of the Self is engaged in a discussion which concerns the ‘self-acting’ individual conducting life beyond social policies and welfare options.

Nevertheless individualisation is a societal process where several ‘shoves of individualisation’ could be identified (Majan 1998: 170). These changes between the individual and society cause several dimensions of individualisation (Kippele 1998: 242) whereas the autonomy of the individual (i.e. possibilities in societies, self-control, self-response) is a central aspect of individualisation. Moreover, our life styles which could be expressed about brands or branding not only demonstrate the personal position of everyone in society (Quart: 2003), but also the economic concept of utilisation: this dominates the self whether finding a work place and/or being a hyper creative individual (Keupp ebd.). Individualisation is not a single topic for society. In combination with diversification (i.e. of products or lifestyles) it offers on the one hand lots of possibilities which are identified as a well appreciated side effect, but on

[1] See Rosa (2005) for social and technical acceleration as a driving force in societies.

the other hand it causes disorientation and complexity (Matjan ebd. and Kippele ebd.).

Diversification

Diversification is a broad notion for other terms like change, diversity, pluralism or pluralisation. The access to the topic of diversification is given by two points. The first one explains the concept of diversification which could be summarised to aspects of consumer culture or the area of market research. With regard to market constellations, Bruno Hake (1966: 19ff.) explains diversification as a concept which not necessarily means growing production, but the development of new products while reaching new target groups as customers. The second point is the sociological perspective allowing a discussion about effects of diversification for societies. With regard to that topic the sociological perspective occupies the causes and side effects instead of developing strategies for diversification. Accordingly, this meta-perspective gives a different idea of diversification. In general, one possibility to identify the phenomenon is to describe it as pluralism or diversity of life styles and products. In particular, as a second step, diversification means the reduction of complexity of systems (Kippele ebd.) (i.e. velomobile producers).

Moreover, individualisation in combination with diversification is a 'common' and 'accepted' topic in knowledge-societies and therefore an argument that both topics are function as a mean to an end in order to describe social order. Apart from a positive definition a negative explanation is standardisation or automation which symbolise fordistic and tayloristic working schemes (Matjan 1998: 171ff.). Georg Ritzer (1993) describes this negative effect of individualisation as the *"McDonaldization of Society".* With regard to diversification a need for stabilisation in societies is described (Baumann ebd.). Furthermore, the identification of the paradoxical situation between diversification and standardisation shows how 'fragile' societies react towards unstable, unpredictable structures or in other words: the dynamics of complex structures within societies is visible and stable structures are responsible for regulation.

In general, the system-theoretical perspective after Nikals Luhmann explains how systems and their complexity work (Degele/Dries ebd.). In particular, this theory suggests that each system in modern society produces its own complexity. Therefore, the access to other systems is limited by barriers of specific 'structures'. The usage of 'binary codes' (i.e.: system of economy: have vs. have not; system of sport: victory vs. defeat) and ‘programs of communication’ (economy: investment in diversification; Sport: rules of competition) guarantee a certain understanding and interlinking with other systems (Degele/Dries ebd). Complexity is caused by every system itself (Degele/Dries ebd.). Therefore, one consequence for the individual is less (social) orientation and/or in other words: diversification confronts the individual with a growing perspective of powerlessness (Kippele ebd.: 240). The explanation whether individualisation in relation to diversification causes positive or negative effects is one topic which focuses the discussion on a perspective describing how systems ‘organize’ their complexity or how every system tries to reach acclimatisation.

Avowedly, every system is dealing with its own logic (politicians and their promises before elections). Therefore, the constitution of societies from a system-theoretical viewpoint could be described as a so-called ‘shoe box society’. Moreover, the individual is part of a system, but not a part of the society itself. Also, the individual expresses diversity about posttraditional communities which are one last source for social guidance and security (Hitzler et al. 2008). This re-embeddedness works with the help of (cultural) topics. Instead of counting on ‚traditional’ structures, i.e. family, clan, village etc (Tönnies 1991), these forms of collectivisation exist without any spacial reference. Moreover, Gregor Marjan (1998: 172) suggests that the social net acts within a limited social and political horizon. This discussion leads to the question how an individual gets access to other systems? With regard to the reduction of complexity, one common means is the concept of counselling for knowledge-societies. The ‘looking for advice society’ tries to handle individualisation and diversification by means of minimisation of complex irritations.

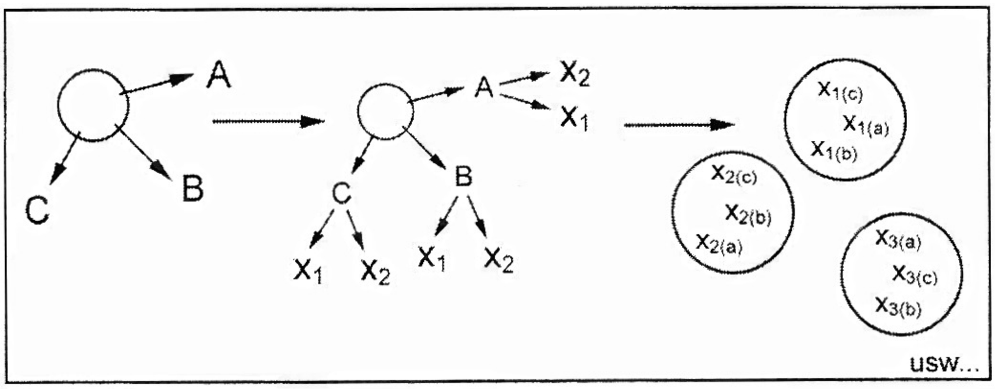


Illustration 1: Subtly Distinction and functional order (Degele/Dries 2005: 79).

3. We live in the age of counselling

Velomobiles have a lack of identity and vehicle development is narrowed because of societal view on personal transport (Cox / Van de Walle 2007: 126ff.). Therefore the complexity of the system called transport is already reduced to a certain minimum of understanding how transport should be (if we like it or not![2]). Nevertheless, apart from the fact that this system knows very well not only how to reduce complexity but also to transport that message (information) clearly to its participants, it seems that velomobile producers can't manage to transport information of the enormous technical richness of velomobile types (Dydymos 1990).

The argumentation (part 2) that diversification on the one hand is a driving force and on the other hand is the cause for uncertainty (Marjan ebd.) follows the perspective of an 'advisory society' (Faust 2006: 277). The assumption that counselling has a 'clearing-up' function confirms the meaning as a social reference in society. Moreover, this constellation relies on asymmetric knowledge as well as on the assumption that the consulting person has a 'problem'. Also, the counsellor is more than an expert. An expert has a special knowledge in his/her field which allows giving expert's opinion. The counsellor needs some more qualifications because the consulting person needs advice for a certain problem. Therefore, the counsellor has to 'translate' technical or special language into 'every-day-language'. This means that counselling must be the intervention of possibilities, technical expertise and general knowledge. According to the consulting person, it is assumed that empathy for a development of the different life styles (= individualisation) helps. Moreover, a set of pluralistic patterns of counselling is required as well as principles (or codices) to produce trust (Alemann ebd.).

Counselling is a social situation which relies on trust between two persons. In addition, the activity is time limited but not necessarily a single event. The situation of counselling constitutes options which means that counselling makes offers for the consulting person but it is not offering final solutions. Security is created because special knowledge is offered. Finally, the consulting person has to make a decision which means (again) risk taking. The counsellor offers knowledge but not the final testing of it. Therefore, the consulting person is not only confronted with an asymmetric situation of counselling but also with the acceptance of power differences. The

[2] With regard to the car system everyone knows it's re-production of complexity: traffic jams, pollution, climate change etc…

performance of the counsellor has to be perfect in order to take a convincing position. Moreover, the 'logic of a counsellor' doesn't allow incompetence at all.

Chart 1: Counselling in Postmodernism

Counselling and Society	Characteristic	Dimensions
Microlevel of counselling (Interaction of two persons)	Interaction of two partners; asymmetric power constellation	Unsecurity is a condition for counselling (How to make one to look for advice; How to reduce complexity) Process of understanding and definition.
Macrolevel of counselling Institutions, like private and public forms of counselling (banks, funeral directors, spiritual welfare, child guidance service, welfare state	Postmodernism causes demand of counselling (unresting and helpless society)	Every system creates its own performance of counselling

Own demonstration, following Faust (2006), Alemann (1996).

4. Velomobile producers and the scenario of counselling

There has been a remarkable development in model diversification as well as a substantial increase in the number of velomobile producers in the last 15-20 years. The development of velomobiles shows that the producers understand how to create a wide range of different model types as the "individualisation code" demands. Moreover, velomobile producers are experts within the system. They are busy with developing (or technical acceleration) (Rosa ebd.) rather than thinking about social constellations of action. The lack of development of a professional counselling scenario is to be identified as well as velomobile counselling takes place within the social networking community. Accordingly, the constellation of velomobile counselling is a product of social networking. In general, counselling offers different scenarios towards pluralism of life styles (codes of individualisation), and in particular the network counselling offers a common general knowledge, which determines a certain 'state of the art counselling'.

With regard to an analysis of a counselling situation, it is a process and not a singular matter which gives an alignment. Moreover, the purpose is to produce a stable situation and not a "maze" of general knowledge. With regard to the internet-counselling situation, it is necessary to find common codes for velomobile consulting instead of re-producing complexity. Michael Faust (ebd.: 284) assumes that social networking produces institutionalised knowledge which ties a certain attitude. The point to mention is not the valuation of social networking rather than the explanation how systems work and react and how stable structures can be. The current client who is interested in buying a velomobile relies on the networking scheme where all ‘sorts of information’ are given or superficial knowledge is presented. Therefore, the networker is not an expert as closely as the expert is not a counsellor. Moreover, the expert has to develop a ‘counselling scenario’ in order to get access to the system (or not to lose the access) of clients. The access happens if the counsellor is able to give orientation or the translation of the expert language. The crucial point for the counsellor is to get access to each client and not to use one counselling method like a recipe (=individualisation demands individual attraction). Professional velomobile counselling would be able to break down diversification onto a level on which the counsellor produces transparency by using his/her expert knowledge and translating it.

One consequence of the development of an own systematisation of counselling of the velomobile producers would be a certain division of the network community. In comparison to the network counselling, the systematic of the producers would be different in order to distinguish it; otherwise both systems would produce a whole bundle of complexity. One constructive question would be how social network community and velomobile producers might concentrate their capacities. The strategy to develop a different concept would produce ‘scapegoats’, because of the loss of ‘political correctness’. It is to assume that members feel betrayed[3]. Furthermore the concentration of competences seems a possible answer because of limited resources (developing diversification AND counselling).

5. Summary

Counselling is an underestimated aspect in the discussion of velomobiles and their diversification. There is a lack of descriptions concerning cycling in society in general and ‘velomobile cycling’ in particular. Moreover, not only cycling and counselling are no topics at all but also velomobile producers leave counselling to the network community. Cycling is more a political off state within our society rather than a serious

[3] Faust (2006) describes similar scenarios for the area of management consulting. In terms of cycling: some VSF (working co-op bike shops in Germany now more than 150) gave up the idea of working as co-op’s. During this development it was easy to tell who will be the winners and losers or the so called scapegoats of that discussion. The ones who decided to choose a more professional way of counselling for cycling or for bike trade were confronted with criticism of a political idea.

topic. Therefore, establishing a system which takes topics like counselling serious might be an access to demonstrate the seriousness of over 50 years of experience. One forecast for the future could be to establish a professional velomobile counselling scenario in order to get more transparency or a growing acceptance by the society.

6. References

Alemann von, Heiner (1996): Einige allgemeine Bemerkungen zur Soziologie der soziologischen Beratung. In: Alemann v. H. / Vogel, A. (Hrsg.): Soziologische Beratung. Praxisfelder und Perspektiven. IX Tagung für angewandte Soziologie. Opladen.

Baumann, Zygmunt (1997): Flaneure, Spieler, Touristen. Essays zu postmodernen Lebensformen. Hamburg.

Cox, Peter / Walle, Frederick van de (2007): Bicycles don't evolve: Velomobiles and the modelling of transport technologies. In: Horton, Dave / Rosen, Paul / Cox, Peter (Ed.): Cycling and society. Hampshire / Burlington.

Degele, Nina / Dries, Christian (2005): Modernisierungstheorien. München.

Dovydėnas, Vytas (1990): Velomobile. Berlin.

Faust, Michael (2006): Soziologie und Beratung – Analysen und Angebote. In: Sozioologische Revue, Jg. 29, S. 277 - 290.

Foucault, Michel (1977): Überwachen und Strafen. Die Geburt der Gefängnisse. Frankfurt am Main.

Hake, Bruno (1966): Die Suche und Auswahl neuer Produkte. Die Praxis der Diversifikation. München.

Hitzler, Ronald / Honer, Anne / Pfadenhauer, Michaela (2008): Posttraditionale Gemeinschaften. Theoretische und ethnografische Erkundungen. Wiesbaden.

Keupp, Heiner (2003): Zukünfte des Individuums: Fitness für den Markt oder Selbstsorge in der Zivilgesellschaft. In: Birbaumer, Andrea / Steinhardt, Gerald (Hrsg.): Der flexibilisierte Mensch. Subjektivität und Solidarität im Wandel. Heidelberg.

Matjan, Gregor (1998): Auseinandersetzung mit Vielfalt. Politische Kultur und Lebensstile in pluralistischen Gesellschaften. Frankfurt/Main.

Pooch, Andreas (2009): Die Wissenschaft vom schnellen Radfahren II. Troisdorf.

Rosa, Hartmut (2005): Beschleunigung. Die Veränderung der Zeitstrukturen in der Moderne. Frankfurt/Main.

Simmel, Georg (1992): Alpenreise. In: Dahme, Heinz-Jürgen / Frisby, David F. (Hrsg.): Georg Simmel. Aufsätze und Abhandlungen 1894 bis 1900. Band 5. Frankfurt am Main.
Tönnies, Ferdinand (1991): Gemeinschaft und Gesellschaft. Grundbegriffe der reinen Soziologie. 3. Auflage. Darmstadt.
Quart, Alissa (2003): Branded. Wie wir gekauft und verkauft werden. München.

Velomobile aerodynamics – side wind effect and operation limits

by Carl Georg Rasmussen

6th Seminar on Velomobile Design 16. - 17. October 2009

Abstract

The wind and the speed of a velomobile cause aerodynamic forces on the fairing, which can be dangerous under extreme conditions. In order to ride in a safe way, it is important to know the operation limits.

The wind can also be helpful. The sail effect adds to the propulsion even in side wind, where there is a considerable head wind component.

Wind tunnel measurements on different types of fairings give more insight in this phenomena.

In velomobile design it is often necessary to make trade offs of ideal aerodynamics to obtain a practical function. E.g. some fairings use a partly open bottom in order to make better conditions for the cyclist to enter and to get out of the vehicle. How much does it mean to the aerodynamical drag?

This, and other design detailles were studied by measuring the drag on a Leitra velomobile in down hill experiments.

Wind tunnel experiments

When riding a velomobile in the wind, it is not easy to measure the actual aerodynamical forces on a fairing. It is better to use wind tunnel experiments, where wind speed and forces can be measured under controlled conditions.

Since we have no access to make full scale wind tunnel experiments (a privilege for big car makers), it was necessary to use models in a smaller scale. We chose scale 1:5, which could fit into a 50 x 50 cm test section of a wind tunnel at the Technical University of Denmark (DTU).

In order to obtain the same Reynolds Number (Re) as in full scale experiments, the speed (U) was set as high as 32 m/sec (115 km/h). The models had a width (D) of 14 cm, which results in

$$Re = \frac{D \cdot U}{\nu} = \frac{0.14 \text{ m } 32 \text{ m/sec}}{15 \cdot 10^{-6} \text{ m}^2\text{/sec}} = 3 \cdot 10^5$$

They were mounted in the test section on a thin steel rod, which could be rotated in the air stream to different angular positions. The steel rod was attached to a weight, which measures the horizontal or vertical force directly in N (Newton). Measurements were made in steps of 5 degrees, covering a range of +/– 45 degrees.

The results are shown in Fig. 2 and Fig. 3. The horizontal force (the direction of the air stream) and the vertical force are shown as a function of the angle of incidence θ.

Fig. 1 shows the three models used:
(1) a very slim and aerodynamical reference model, to the left.
(2) a model of the Leitra "sport" fairing with and without bottom, front right.
(3) a model of a Leitra "classic" small size fairing, back right.

Fig. 2. Forces on a 1:5 scale model of Leitra "Classic" small size at 32 m/sec.
The right side shows drag and lateral force on the model at different angles of attack.
The small curve covering only +/– 20 degrees is for the aerodynamical reference model.

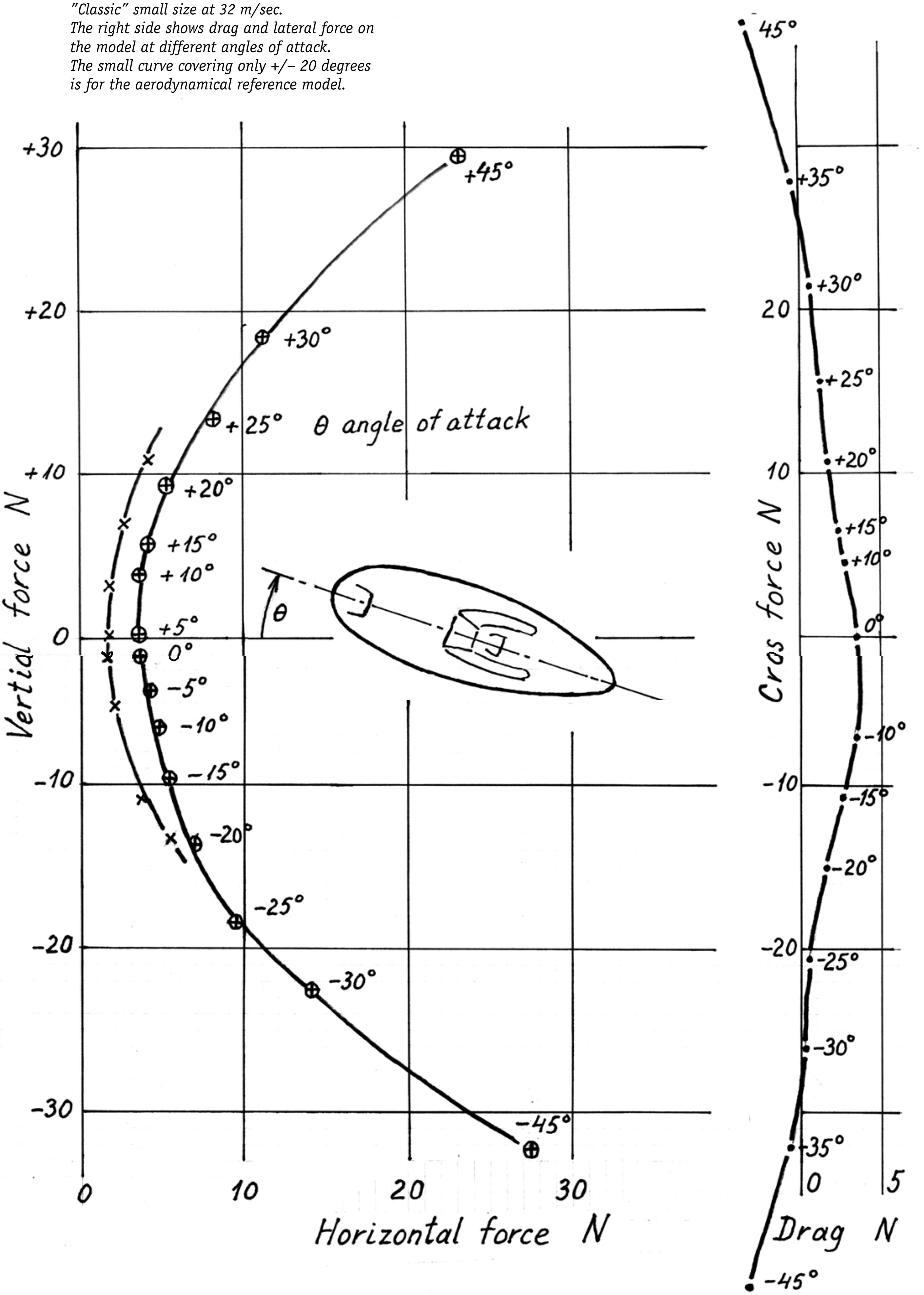
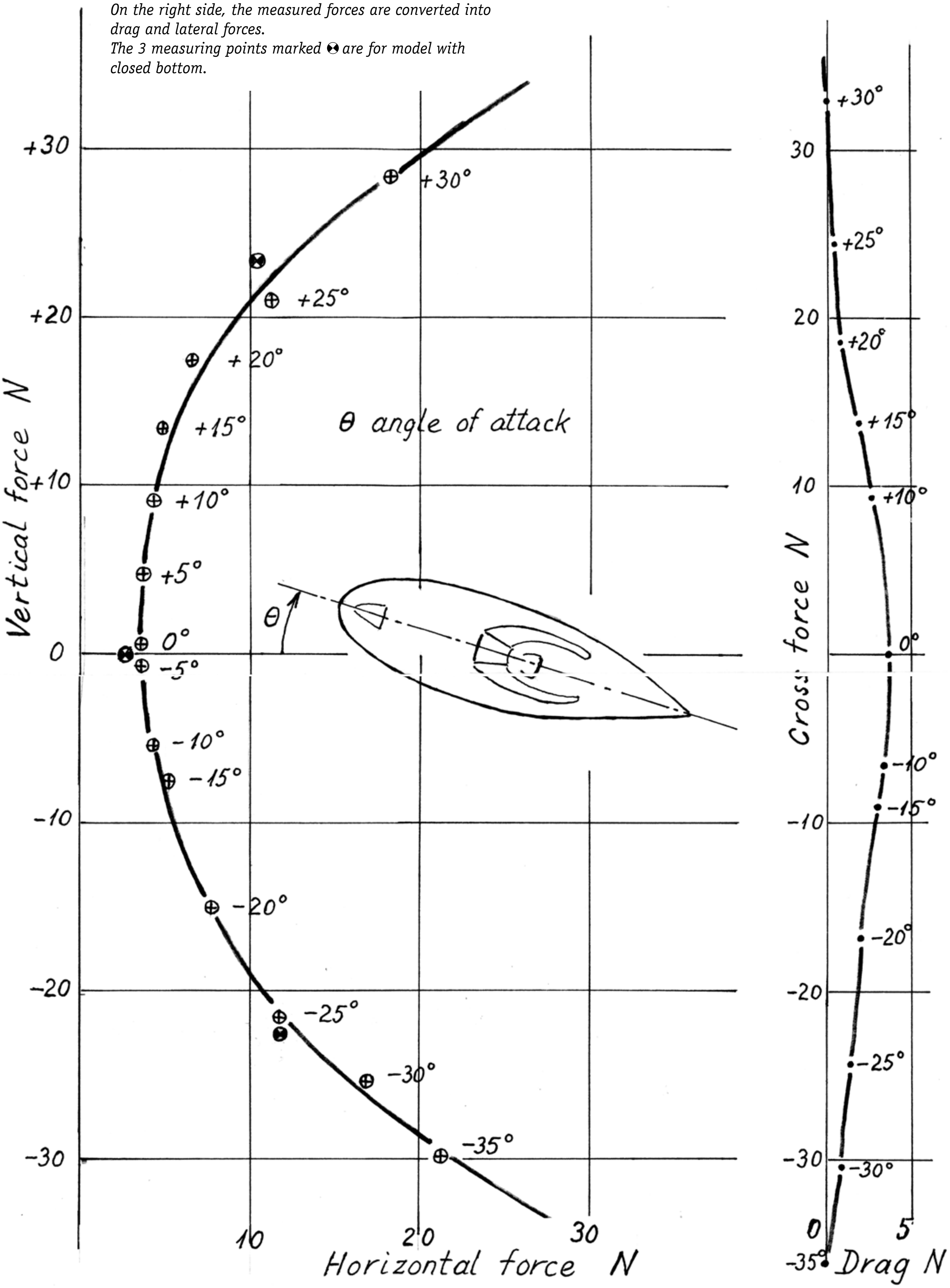
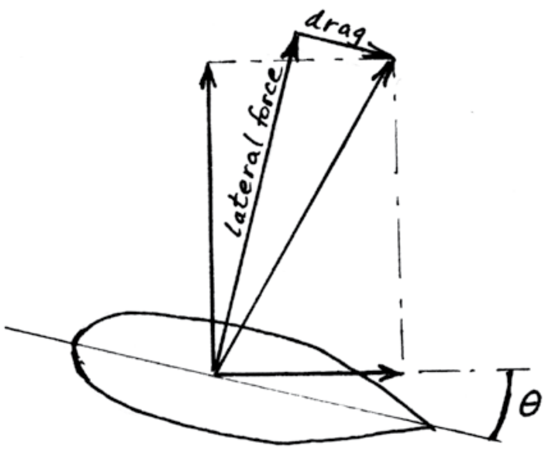


Fig. 3. Forces on a 1:5 scale model of the Leitra "Sport" at 32 m/sec.
On the right side, the measured forces are converted into drag and lateral forces.
The 3 measuring points marked ⊗ are for model with closed bottom.





The diagram with direct measurements can be transformed into an other diagram, which shows the forces as drag and lateral force at different angles of incidence, see right side of Fig. 2 and Fig. 3.

The drag is seen to decrease, when the model turns away from the flow direction, and at approximately +/– 33 degrees the drag disappears, and at larger angles of attack it becomes negative, i.e. the model gets a push forward.

This observation is confirmed when riding a Leitra velomobile in side wind. In a head/side wind,

coming from 60 degrees, and at a speed of 10 m/sec, the drag is not noticable, and in direct cross wind you feel a light push. You do not get full advantage of the sail effect, because at the same time the rolling resistance will increase, since you have to steer against the cross wind, which causes higher friction between wheels and road.

Other velomobile designers have tried to optimize the sail effect. The company Birkenstock in Switzerland made similar wind tunnel experiments with a "Butterfly" model, and they found the shift from drag to push to occur at a slightly smaller angle. Data from a diploma thesis by J. R. E. Diener indicate 25-30 degrees as the angle of attack, where the shift in drag occurs. The model of the "Butterfly" is more slim, has a higher tail section, and the shape is more like a vertical air foil.

From the measurements we can calculate the drag coefficient C_D of the models. All measurements were made at 32 m/sec, which gives a dynamic pressure of

$$P = ½\rho \cdot U^2 = ½ \cdot 1.2 \text{ kg/m}^3 \cdot (32 \text{ m/sec})^2 = 614 \text{ N/m}^2$$

and with the cross section A and the drag at angle of incidence $\theta = 0$, we get:

	Drag F	**F/P = C_D A**	**A**	**C_D**
Model 1	1.5 N	$2.44 \cdot 10^{-3}$ m²	$1.60 \cdot 10^{-2}$ m²	0.15
Model 2 + bottom	2.6 N	$4.23 \cdot 10^{-3}$ m²	$2.28 \cdot 10^{-2}$ m²	0.19
Model 2 – bottom	3.2 N	$5.21 \cdot 10^{-3}$ m²	$2.17 \cdot 10^{-2}$ m²	0.24
Model 3	3.4 N	$5.54 \cdot 10^{-3}$ m²	$2.17 \cdot 10^{-2}$ m²	0.25

The model experiments indicate, that closing the bottom of the fairing could give as much as 20% reduction of the drag. The reduction is much less, when the model has a small angle of attack.

However, the model was placed in the free air stream, far from walls, which could simulate ground effect from the road. Therefore, further studies of the effect of closed bottom will be made on the road under full scale conditions.

Stability and operation limits

The Leitra is a tadpole trike with a relatively short wheel base and a wide track. This is to obtain high manoeuvrebility and high turn over stability. The configuration is shown in Fig. 4.

The seat is a little higher, and not as recumbent as many other recumbent trikes. This is to provide a good overview and easy visual communication in traffic.

Let us first consider the stability by manoeuvring, in particular by sharp cornering. This is determined by the level of the centre of gravity over the ground and the minimum horizontal distance between the centre of gravity and the line of turn over.

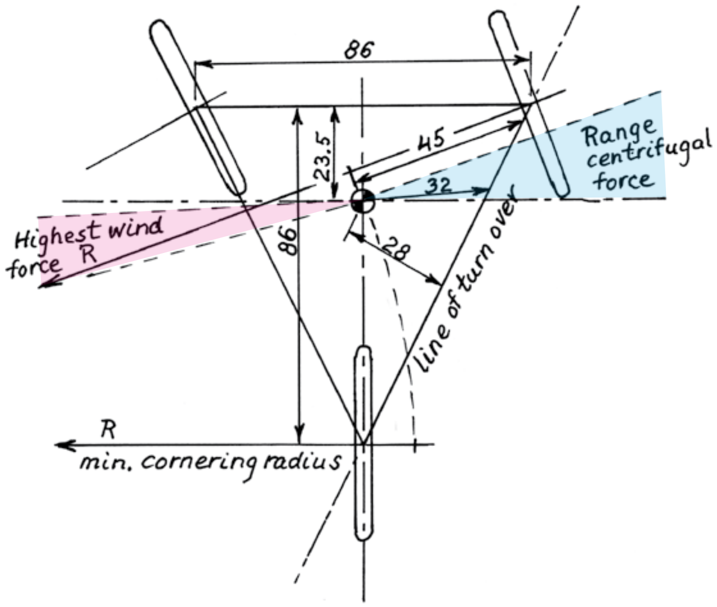


Fig. 4. Wheel configuration of a Leitra velomobile, with centre og gravity (velomobile + rider + no luggage).

An empty Leitra "Sport" with full fairing, including aerodynamical front wheel fairings and heavy duty tires, has the centre of gravity 36 cm over the ground, and a rider (180 cm/70 kg) has centre of gravity approx. at a level of 52 cm. With a mass distribution of 34.5 kg for the velomobile and 70 kg for the rider (total 104,5 kg), we get a common centre of gravity at a level of 47 cm.

The horizontal position og the centre is shown in Fig. 4, and we see, that the critical moment for turn over is:

$$M \cdot g \cdot 0.28 \text{ m} = M \cdot 2.75 \text{ m}^2/\text{sec}^2 \qquad [1]$$

where M is the mass and g is the gravity accelleration. By steep cornering (R = 2 m) the centrifugal force will turn forward towards the front wheel, resulting in a longer moment arm and a critical turn over moment of:

$$\frac{M \cdot U^2}{R} \quad \frac{28}{45} \cdot 0.47 \text{ m} = \frac{M \cdot U^2}{R} \cdot 0.292 \text{ m} \qquad [2]$$

From [1] and [2] we see, that with a cornering radius of R = 2m and a speed of 4.34 m/sec, or 15.6 km/h we reach the condition for turn over.

From this we learn: Never exceed a speed of 15 km/h in steep turns.

For larger cornering radius the speed limit will be $U \leq 2.6 \text{ sec}^{-1} \sqrt{R \text{ m}}$

With heavy load in the rear luggage box, perhaps a child in special fairing with child seat, the critical cornering speed is even lower. On the other hand, heavy luggage under the seat will make the velomobile more stable.

Stability in the wind is another important factor for safe riding. While the centrifugal forces by manoeuvring never will take the direction most sensitive to turn over, the wind can take any direction.

However, as we have seen from the wind tunnel experiments, the wind force shifts quickly to a dominating lateral force, as the angle of attack increases beyond 10 – 15 degrees.

When riding in strong side wind, you will tend to reduce the driving speed for safety reasons.

The wind speed Uw will then be the determining component of the relative air velocity, and we may disregard the driving speed.The level (h) of the aerodynamical pressure centre is estimated to be 55 cm above the ground, and the area of the fairing seen from the side is 1.81 m^2.

Unfortunately, the wind tunnel measurements did not cover angles of attack beyond 45 degrees.

Therefore, the maximum lateral force is not known exactly, but if we assume a lateral C_D = 1.0, we can estimate the turn over moment of the wind:

$$\tfrac{1}{2}\rho \cdot U_w^2 \cdot C_D \cdot A \cdot \tfrac{28}{32} h =$$

$$\tfrac{1}{2} \cdot 1.2 \text{ kg/m}^3 \cdot U_w^2 \cdot 1.0 \cdot 1.81 \text{ m}^2 \cdot \tfrac{28}{32} \cdot 0.55 \text{ m} =$$

$$U_w^2 \cdot 0.52 \text{ kg}$$

If we put the wind moment equal to the critical over turn moment

$$U_w^2 \cdot 0.52 \text{ kg} = M \cdot 2.75 \text{ m}^2/\text{sec}^2$$

we can find the wind speed, where an over turn may occur

$U_w = \sqrt{M\ 5.3 \text{ kg}^{-1}}$ m/sec,
with M = 104.5 kg,
we get a critical wind speed U_w = 23.5 m/s

I weigh only 59 kg, so my personal limit is slightly lower. To be on the safe side, I set my personal limit at 20 m/sec.

When riding in strong side wind, the velomobile tends to make small jumps sidewards, and you have to keep against the wind with the steering.

If the wind causes an over turn, you slide on the side and may even find yourself in a rolling velomobile. I have been swept off the road a few times in gusts at 25 –30 m/sec in my 30 years as velomobile rider.

Perhaps I should come up with one more warning. If the side wind is strong, but not strong enough

Fig. 5. Leitra "Sport" side view with centre og pressure and centre of gravity.

to cause an over turn by itself, you manoeuvring is critical. You should never make fast and steep turns against a strong side wind. In this case you will have centrifugal and wind forces working same way.

It is better to turn away from the wind, if this is possible.

The stability can, of course, be improved by more load in the luggage compartments under the seat. Therefore, I prefer to ride an electrical version of the Leitra under extreme wind conditions. It has the batteries placed low under the seat.

When the vehicle is parked empty, it may well fly away with the wind, if it isn't moored properly.

And a final hint: Always open the fairing against the wind.

Aerodynamical drag measured full scale

The step from wind tunnel measurements in the laboratory, on small scale models, to full scale experiments under more realistic conditions may lead to a number of possible disturbances.

In order to obtain a reasonable accuracy, it is necessary to select the free air conditions carefully.

The effect of wind, other traffic, road conditions, tire pressure etc. should be kept at a minimum.

As test stretch we found a road with a 4.23 % slope, fairly constant over a distance of 1 km.

The best time to perform the experiments –with least traffic – is a sunday morning, and if the weather happens to be dry with little or no wind, your patience has been rewarded, and you can start the down hill coasting experiments.

The vehicle is accelerated to an initial speed, in these experiments around 35 km/h, and at time zero logging of the speed (U) starts while free wheeling downhill. The run is repeated several times to improve accuracy. The accelleration downhill dU/dt , which can be measured from the U versus time recording, is given by

$$dU/dt = (a - C_R) \cdot g - ½\rho\ (U + U_w)^2\ C_D\ A/M$$

where a is the slope, C_R is the coefficient of rolling resistance, C_D the drag coefficient, A the frontal area of the velomobile and M is the mass of vehicle + rider. From the above formula we find:

$$C_R = a - \frac{dU/dt}{g} - \frac{½\rho\ C_D\ A\ (U + U_w)^2}{M\ g}$$

and

$$C_D = \frac{(a - C_R)\ M\ g - M\ dU/dt}{½\rho\ A\ (U + U_w)^2}$$

C_R can be found from measurements, where the speed, and thereby the aerodynamical drag, is low.

C_D can then be calculated from recordings at higher speed, where rolling resistance is small compared to the aerodynamical drag.

Let us first find the C_R coefficient from coasting downhill a weak slope of only 0.013.

The recordings are shown in Fig. 6.

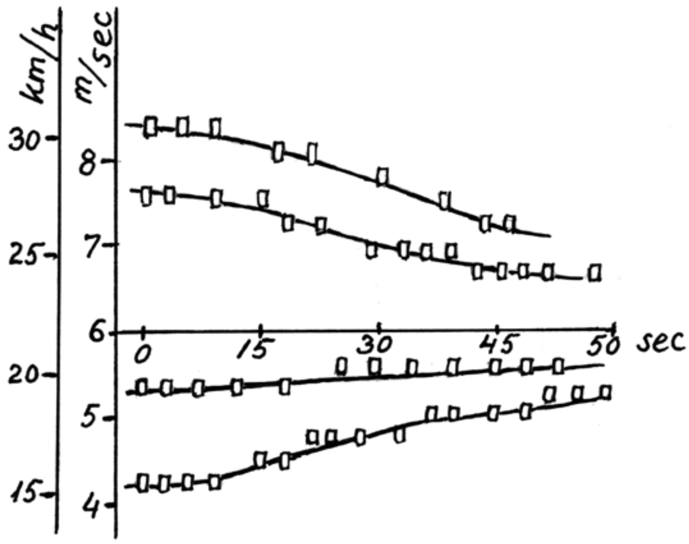


Fig. 6. Recording of speed as a function of time, measured by coasting down a 1.3 % slope on rough asfalt with Schwalbe Maraton + tyres at 5 bar. No wind.

With an initial speed of 30 km/h the vehicle slows down, and at a lower initial speed, 15 km/h, it accelerates. From the recordings we can measure dU/dt at a given speed, and if we set

$C_D\ A = 0.2 \cdot 0.61\ m^2 = 0.122\ m^2$, $M\ g = 920$ N,
and $U_w = 0$, we can calculate the C_R from the four runs in Fig. 6

Run	M dU/dt	U	C_R
1	– 2.6 N	7.78 m/sec	0.011
2	– 1.9 N	6.95 m/sec	0.011
3	+ 0.43 N	5.55 m/sec	0.010
4	+ 1.9 N	4.72 m/sec	0.009
		Mean value	0.010

We then move to the steeper slope a = 0.0423 and start coasting at time zero with an initial speed around 36 km/h (10 m/sec). The speed is recorded over a period of 50 seconds, and the rider then pedals slowly uphill for a new run. The results are shown in Fig. 7 and Fig. 8.

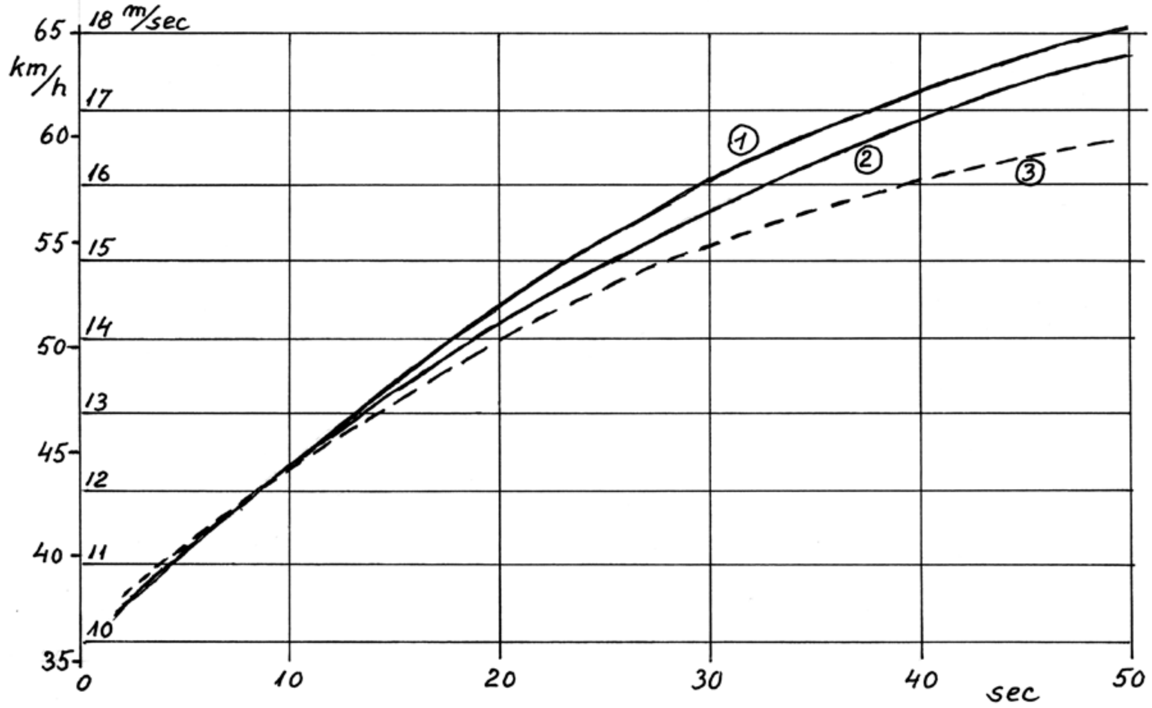


Fig. 7. Downhill coasting on a 4,23 % slope with Leitra "Sport" fairing, open bottom.

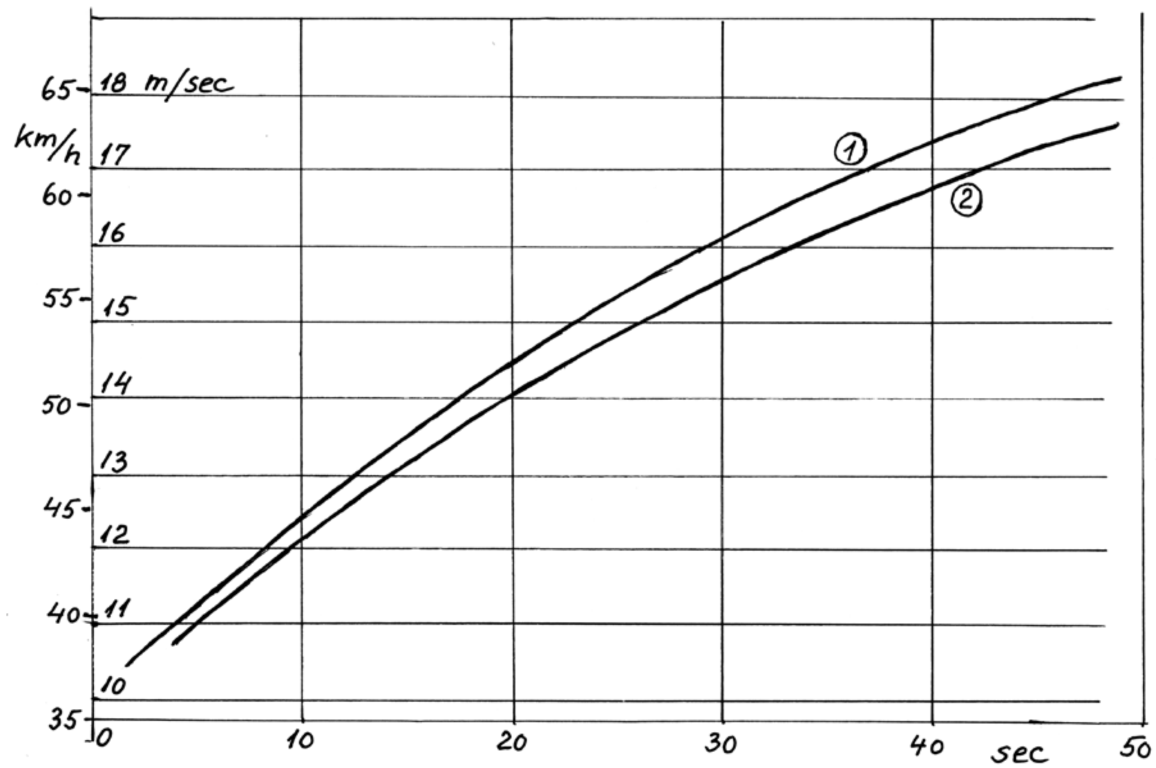


Fig. 8. Downhill coasting on a 4.23 % slope with Leitra "Sport" fairing, closed bottom.

From the two recordings 1 and 2 in Fig. 7 we can calculate the C_D at different speeds.

The average values are found to be: C_D = 0.178 +/– 0.011 and C_D = 0.175 +/- 0.008 respectively.

In the run ③ the aerodynamical fairings on the front wheels were removed.

This resulted in a C_D = 0.216 +/– 0.005, or an increase of 21-23 % of the drag.

Wheel fairings are, therefore, essential for low aerodynamical drag on a velomobile, which has the wheels outside the front fairing.

Another question, which has often been discussed, is how much an open bottom may add to the drag. Coasting experiments offer an opportunity to make direct comparisons.

The bottom of the Leitra "Sport" fairing was closed with a plate covering the whole bottom from the nose to the rear wheel, see Fig. 9

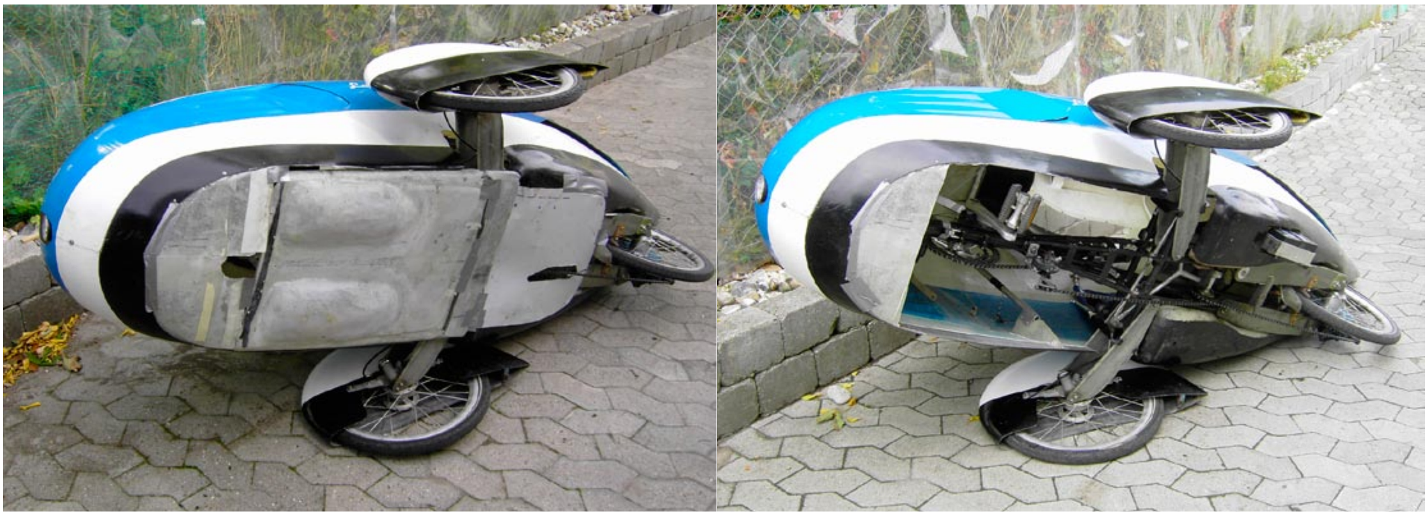


Fig. 9. Leitra "Sport" fairing with and without closed bottom.

From the recording ① of velocity as a function of time, shown in Fig. 8, we find C_D = 0.161 +/– 0.008. A completely closed bottom has in this experiment reduced C_D by 9%.

The second run ② with closed bottom shows a significant anomali, with C_D = 0.194 +/– 0.008.

The reason was found to be an oversight by the rider. He forgot to close the air inlets on the sides of the fairing after a hot uphill return ride. The result was a 20 % increase of the C_D.

If you want to race with a Leitra "Sport", it is recommended to close the air inlets completely.

Tools and accuracy

With the rather primitive instrumentation used in these experiments, one can not expect an accuracy better than 5%. The speed of the velomobile was recorded with a normal cycle computer, showing km/h in steps of 1 km/h. A speed of, say 30 km/h, can, therefore, not be detected with an accuracy better than 3%. Also the time of the reading of the speed has an uncertainty, say 1 second.

From Fig. 6 one can get an impression of the uncertainty of the individual measuring points.

In order to obtain higher accuracy, recording of the speed must be done with a resolution of 0.1 km/h. Also the sampling frequency must be higher, with an uncertainty of a fraction of a second.

With such tools, it would be possible to study aerodynamical effects of minor modifications in the design.

Acknowledgment

The wind tunnel experiments were performed at the Technical University of Denmark, Section of Fluid Mechanics. I am thankful for the help and assistance I received from ass. prof. Robert Mikkelsen.

From Dr. Andreas Fuchs I received a copy of the thesis by Jan R. E. Diener, who made wind tunnel studies of the Birkenstock "Butterfly" velomobile. It offered an opportunity to make interesting comparisons.

References:

Diploma thesis EPFL, Jan Raino Eerik Diener, 20.02.99
http://www.speedbikes.ch

Présentation pour le séminaire de conception de Copenhagen 2009

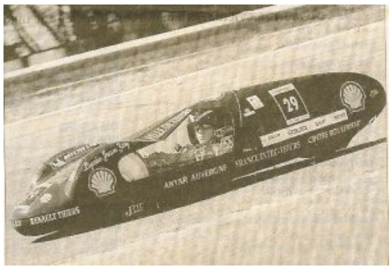
Sylvain Lemoine pour Vélovergne

Le Vélomobile accessible à tous

Prèsentation:

Sylvain Lemoine, Diplômé des Arts et métiers en 2001; spécialisé dans les énergies renouvelables en 2002, c´est en menant une recherche sur le mode vie durable que le vélomobile m´est apparu comme un véhicule optimum pour le transport individuel. Dans le cadre de l´association 2 bien fêteur nous développons le vélomobile pour tous.

A- Le développement du projet Vélovergne:



L´écomarathon shell en 1993, le festival du vent en 2001, et les championats du monde de vélos-couchés en 2006 ont été les déclencheurs de cette démarche de recherche de véhicules abordables: c´est à travers internet que j´ai pris contact avec TW Bent, j´ai acheté un trike tadpol. Puis je me suis rapproché de l´ADV (Association de Développement de Vélomobile) afin de réaliser avec Daniel Couque une première carrosserie. (09/2007)

Je me suis ensuite rendu au Taïpei cycle show afin de rencontrer les 2 fabricants taïwanés: Tw Bent et Performer. En effet la Création d´Activité Durable Ethique (CADE), suppose un minimum de connaissances des méthodes de fabrication mais aussi des conditions de travail. Le contexte socio-économique global, permet à Taïwan, grace aux états unis, de fabriquer des vélos-couchés performents et de bonne qualité: savoir-faire dans la construction de cycles, fournisseur pour le monde entier, et partenariat pour la conception avec actionbent.

Ensuite est venu le temps de rencontrer les maîtres des HPV: au SPEZI 2008. Découverte concrète des produits finis ; les choix du vélomobile utilisable pour tout m´ont conduit auprès de Leitra. J´ai ensuite gagné le Danmark pour ajuster un Leitra classique à ma taille et partager le quotidien de l´entreprise pendant quelques jours.

Le développement de la carrosserie wildcat est une réelle opportunité pour le projet, car elle intègre les rétroviseurs et le creux entre les genous offre un bonne vision de la chaussée. Son poid et sa simplicité de fabrication en font une réelle entrée en matière de protection aux intempéries pour tous les trikes. J´ai donc réalisé le zèbre en mars 2009 pour offrir au public pionnier une opportunité économique.

Lors de ce second séjour à Ganlose, j´ai rencontré Daniel Backwinkel de Outdoors expert liegerad shop, qui importe les TW Bent pour l´Allemagne. J´ai ainsi pu essayer les nouveaux models de trike pliables et ajustables. Nous avons aussi évoqué une coopération européenne. Car la stratégie de développement est un peu similaire : proposer des trikes bon marché pour voir le nombre d´utilisateurs augmenter, puis arriver à une masse critique pour une production industrielle locale.

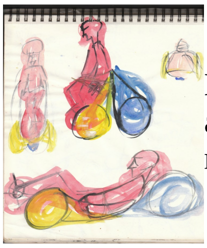
B-L´adéquation offre et demande:

Dans cette recherche de création d´activité locale et d´industrialisation de vélomobile, plusieurs démarches complémentaire ont été misent en route.

B-1 La Solicitation des industriels:

Si la fabrication de vélo est depuis longtemps un savoir faire asiatique, il n´en a pas toujours été le cas. L´économie de marché est une machine infernale vers la baisse des prix, l´industrialisation et les valeurs des monnaies ont été les vecteurs économiques essentiels pour justifier des délocalisations. A cela il faut maintenant prendre en compte que la fabrication des équipements sont aussi une spécialité asiatique. Voila pourquoi nous avons tout d´abord choisi d´utiliser des trikes taiwanés. Notre choix s´est tourné vers TW Bent, pour la direction indirecte ; nous avons solicité le directeur pour appréhender un peu les coûts de fabrications pour des commandes plus importantes.

La fabrication de carrosseries en composit est un savoir faire de plus de 30 ans à Arlanc. C´est aussi une motivation pour le développement local. L´échelle et les méthodes ne sont que des details pour les entreprises si le marché est là. Nous avons donc rencontré plusieurs autres entreprises qui nous proposerons prochainement des devis. (350€ pour le wildcat)



Enfin le pole de compétitivité Via Méca nous a conseillé au cours d´une rencontre après le Satcar 2009, de démontrer l´existance du marché, afin ensuite qu´il nous mette en relation avec des industriels.

B-2 Etude de marché pour un produit inconnu: le vélomobile.

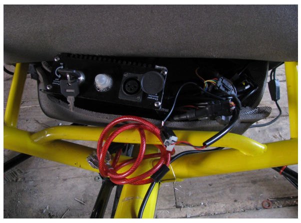
La Région Auvergne nous a attribué une bourse créateur afin de subventionner le développement et l´annalyse statistique d´une enquête réalisé par Projectiv Group une agence de marcketing de Clermont Ferrand. En effet, les données sur le marché européen montrent d´ors et déjà un intérêt grandissant pour ce type de véhicule, mais une étude de marché pour la France devait passé par cette étape de test auprès du public car le vélomobile reste inconnu de la plupart.

Nous avons donc constitué un taxibrousse composé de notre camion associatif, chargé de divers produits à essayer : un kmx enfant, 2 trikes arrow de tw bent, un troisième électrifié, un trike artifice tw bent avec la carrosserie wild cat et un leitra classique. et un prototype ancien de bicyle couché. Nous devons administrer entre 300 et 500 questionnaires (voir annexe 1).

Nous avons choisi de réaliser une première boucle dans le nord-ouest de la France, car c´est une région plate, avec de fortes précipitations et nous avons terminé cette première étape à la semaine fédérale de cyclotourisme. (170 questionnaire administré et plus de 500 essais, plusieurs milliers de personnes ont pu aussi découvrir les véhicules.)

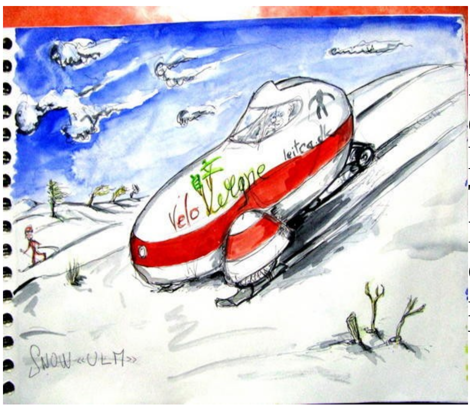
D´ors et déjà nous pouvons confirmer que le marché du trike a un bel avenir devant lui, car malgrès un appriori négatif dans plus 40% des cyclistes pour les vélos-couchés, plus de 80% des testeurs sont étonnés du confort de conduite et de la maniabilité des engins, à tel point qu´il en sont eux-même surpris.

Ensuite, le test du tricycle assisté ouvre chez les plus jeunes, des horizons nouveaux pour du transport quotiden basse consommation. Surtout en zone de relief les testeurs séduits par le véhicule s´interrogent sur les caractéristiques économique et technologique de ces kit électriques. Ce qui soulève encore le problème de fiabilité et d´entretient des systèmes électroniques.



Enfin, la compléxité d´ajustement des carrénages aux pédaleurs, n ´offre par pour l´instant de bon test de vélomobile. Mais la ligne du leitra et du zèbre alimente l´imaginaire collectif ; et ouvre les portes aux nouvelles générations pour entrevoir avec optimisme l´après pétrol. Les données de consomation d´un alleweder (0,1 l/100 km à 40km/h) amènent une perspective nouvelle pour beaucoup de gens très émerveillés par ces véhicules légés.

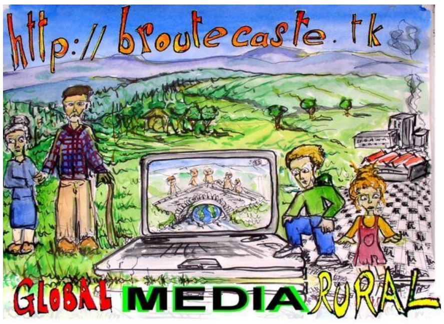
En conclusion intermédaire de cette enquête on peut dire que la sympathie du public est très encourageante et l´ébaïssement des enfants annonce un changement prochain.



Il serait très pertinant en hiver d´organiser un tour de l´Europe en vélomobile fédérant les différents fabricants et continuant les essais du public. Taïwan est déjà dans les starting-bloques : TW Bent attend le marché pour développer des carrosseries. JC Decault et Clear Channel sont les annonceurs publicitaires qui ont installés les vélos en libre service en France, ils ont le moyen de changer la production d´échelle, mais qui seront les bénéficiaires?

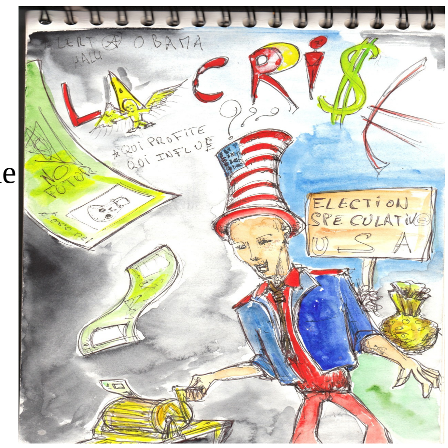
B-3 L´économie transparente au service de l´activité locale:

Au dela du commerce équitable, le commerce transparent est un moyen de créer des fillières durables. Maintenant que les Nouvelles Technologies de l´Information se sont généralisées, Internet apparait comme le moyen le plus populaire de trouver un vélomobile (cf questionnaire). Ce peut être un moyen d´afficher les prix clients mais aussi les coûts de fabrication. Cette transparence sera un moyen pour le client d´être satisfait de son achat. Il pourra ainsi discerner selon ses resources et ses besoins, quel produit convient le mieux à son éthique.



Avant l´effet de mode, les utilisateurs sont des pionniers remplis de convictions. Une organisation transparente est le moyen de mettre en relation des moyens financiers (cigales ou placement éthique), des moyens de production avec leurs coûts et des clients, qui pourrons choisir en conscience type de produit il souhaite utiliser et ce qu´il finance par leur concommation.

Le contexte économique mondial actuel crée un mal-être violent, car l´imaginaire collectif avide de projetss commun pour créer une nouvelle société oú l´épanouissement humain serait le sens de la réussite... En attendant cette évolution, le maintient d´activités économiques est un réel soucis pour bien du territoire.



C - Le Vélomobile dans le mode de vie durable:

Dans sa recherche sur les modes vie durable, l´association 2 bien fêteur mène 5 projets dont vélovergne. Le plus enraciné est probablement celui sur la permaculture qui est une méthode d´aménagement de biosphère nutritive. La première université d´été en France aura lieu cette année, nous y présenterons les vélomobiles.   Nous développons aussi une hutte bioclimatique pour permettre aux citadins d´aménager des zones d´abondances au milieu des campagnes. Ensuite, nous travaillons sur la cogénération solaire biomasse à partir de moteur stirling et des éoliennes à axe vertical, des carrosseries avec des cellules photovoltaïque seront aussi expérimentées. Enfin, la maison de Bourg est en cours de rénovation pour pouvoir acceuillir du public et démontrer qu´une vie plus saine est sûremment aussi plus épanouissante ; elle portera la sagesse de la construction datant de plusieurs siècle et des aménagements de solaire passif facilitant la culture et le chauffage.

Ces considérations viennent apporter une proposition optimiste et constructive au contexte morose de la crise. Il apparait essentiel de rendre à l´homme sa faculté d´imaginer autre chose que la consommation, et d´offrir aux enfants des perspectives d´une société humaine. C´est pourquoi je fais cet appel aux participants pour coopérer ensemble à la promotion des vélomobiles et pour mettre en route un cortège surprenant de véhicules d´avenir, afin de démontrer cet optimum du transport individuel, de proposer la construction collective d´une nouvelle économie.

Annexe: Questionnaire

N°

Bonjour, …., je réalise une enquête sur la création d'un concept de vélomobile (montrer le concept). Pouvez-vous m'accorder un bref instant pour répondre à quelques questions ?

ETUDE FACTUELLE ET D'OPINION

1.Quel(s) mode(s) de transport utilisez-vous et à quelle fréquence ?

	Quotidiennement	Occasionnellement	Jamais
❑ Voiture particulière			
❑ Transports en communs (bus, tram)			
❑ Scooter			
Vélo : ❑ Vélos en libre service ❑ Son propre vélo			
❑ Autres, précisez : …………………………………			

2.Etes-vous satisfait de votre mode de transport quotidien ?

❑Oui ❑ Non

Si non, pourquoi ? ………

Eprouvez-vous des difficultés pour vous déplacer, d'un point de vue :

	oui	**non**
- Financier	❑	❑
- Stationnement	❑	❑
- Accès aux transports en communs	❑	❑

Si l'interviewé utilise le vélo pour se déplacer :

3.Dans quel cadre utilisez vous le vélo comme mode de transport ?

❑Trajet maison – travail ❑ Pendant les vacances ❑ Loisirs – Sport
❑Déplacements personnels ❑ Autres, précisez : ………………………………………………………………………..

4.Pour quelles raisons ?

❑Pratique ❑ Divertissant ❑ Santé / sport
❑Ecologique ❑ N'a pas le permis❑
❑Autres, précisez : ………………………………………………………………………..

Si l'interviewé n'utilise pas le vélo pour se déplacer :

5.Pourquoi n'utilisez-vous pas le vélo comme mode de transport, que cela soit régulièrement ou occasionnellement ?

❑N'a pas de vélos ❑ N'en a pas l'utilité ❑ Dangereux en ville
❑N'aime pas le vélo ❑ Ne sait pas
❑Autres, précisez : ……

TEST DU CONCEPT

Je souhaite commercialiser un nouveau mode de transport individuel, en France, qui s'inscrit dans une logique de développement durable : il s'agit de tricycles qui peuvent être habillés d'un carénage et ainsi rouler par tous les temps, avec la possibilité d'une assistance électrique.

6.Connaissez-vous ce type de concept ?

❑Oui ❑ Non

Si oui, où en avez-vous entendu parler ?

❑Internet ❑ TV ❑ Presse ❑ Vu sur la route ❑ Amis ❑ Salons
❑Autres, précisez : ……

7.Trouvez-vous ce concept intéressant ?

❑Oui ❑ Non *Pour quelles raisons ?*

8.Seriez-vous intéressé pour le tester ?

❑Oui ❑ Non

Si non, pourquoi ?
❑Pas du tout intéressé
❑N'a pas le temps
❑Autres raisons

(allez à la question 11)

Si l'interviewé répond ne pas avoir le temps, lui proposer de passer plus tard dans la journée afin de finaliser le questionnaire et de tester le concept ou de se rendre à un autre endroit, un autre jour suivant le planning de l'enquête.

<u>*Après le test du concept :*</u>

9.Quelles ont été vos impressions après avoir tester le concept de

- tricycle (sans carénage et sans assistance), en termes de :

	Très satisfaisant	Satisfaisant	Moyennement satisfaisant	Pas du tout satisfaisant	Pas d'avis
Confort					
Utilisation					
Praticité					
Originalité					

- tricycle avec carénage (sans assistance), en termes de :

	Très satisfaisant	Satisfaisant	Moyennement satisfaisant	Pas du tout satisfaisant	Pas d'avis
Confort					
Utilisation					
Praticité					
Originalité					

- tricycle avec assistance (sans carénage), en termes de :

	Très satisfaisant	Satisfaisant	Moyennement satisfaisant	Pas du tout satisfaisant	Pas d'avis
Confort					
Utilisation					
Praticité					
Originalité					

- tricycle avec carénage et avec assistance, en termes de :

	Très satisfaisant	Satisfaisant	Moyennement satisfaisant	Pas du tout satisfaisant	Pas d'avis
Confort					
Utilisation					
Praticité					
Originalité					

10.Quel est le tricycle que vous avez préféré ?

❑tricycle (sans carénage et sans assistance) ❑ tricycle avec assistance (sans carénage)
❑tricycle avec carénage (sans assistance) ❑ tricycle avec carénage et avec assistance

11.Seriez-vous prêt à utiliser l'un de ces quatre tricycles ?

❑Oui ❑ Non

<u>*Si oui, lequel*</u>

❑tricycle (sans carénage et sans assistance) ❑ tricycle avec assistance (sans carénage)
❑tricycle avec carénage (sans assistance) ❑ tricycle avec carénage et avec assistance

<u>*Si non, pourquoi ?*</u>

❑N'en voit pas l'utilité ❑ Trop encombrant ❑ Paraît dangereux
❑Le concept ne plaît pas ❑ Pas pratique ❑ Est claustrophobe / carénage
❑Autres, précisez : ……………………………………………… ❑ Par rapport aux regards des gens / image

(allez à la question 15)

12.Dans quel cadre ?

❑Pour les déplacements de tous les jours ❑ Pour les loisirs, le week-end
❑Pendant les vacances uniquement ❑ Autres, précisez :

…………………………………………………

13.Et pour quelle utilisation ?
❑En ville ❑ A la campagne
❑Sur des pistes ou voies aménagés pour les vélos

14.Seriez-vous prêt à acheter ou à louer un de ces tricycles ?
- Acheter : ❑ Oui ❑ Non **- Louer :** ❑ Oui ❑ Non

Si non achat, pourquoi ?
❑Trop encombrant
❑Investissement trop important / utilisation faite
❑Doit être trop cher
❑Entretien trop compliqué / important
❑N'aura pas une utilisation quotidienne
❑Autres, précisez : ……………………………………………

- *Si prêt à louer :*
❑ Location de type vélo en libre service
❑ Location / achat
❑ Location saisonnière à la journée
❑ Location saisonnière à l'heure

Si prêt à acheter, à quel prix ?

	Tricycle (sans carénage et sans assistance)	Tricycle avec carénage (sans assistance)	Tricycle avec assistance (sans carénage)	Tricycle avec carénage et avec assistance
Prix	❑ Moins de 500 € ❑ Entre 500 et 1 000 € ❑ Entre 1 001 € et 1 500 € ❑ Entre 1 501 € et 2 000 € ❑ Entre 2 001 € et 2 500 € ❑ Plus de 2 500 €	❑ Moins de 1 000 € ❑ Entre 1 000 et 2 000 € ❑ Entre 2 001 € et 3 000 € ❑ Entre 3 001 € et 4 000 € ❑ Entre 4 001 € et 5 000 € ❑ Plus de 5 000 €	❑ Moins de 700 € ❑ Entre 700 et 1 400 € ❑ Entre 1 401 € et 2 100 € ❑ Entre 2 101 € et 2 800 € ❑ Entre 2 801 € et 3 500 € ❑ Plus de 3 500 €	❑ Moins de 1 500 € ❑ Entre 1 500 et 2 500 € ❑ Entre 2 501 € et 3 500 € ❑ Entre 3 501 € et 4 500 € ❑ Entre 4 501 € et 5 500 € ❑ Plus de 5 500 €

15.Où penseriez-vous pouvoir trouver un de ces tricycles ?
❑Grande surface alimentaire (type Auchan, Carrefour, Leclerc, Géant) ❑ Internet
❑Magasin de sport (Décathlon, Sport 2000, …) ❑ Vente par correspondance
❑Magasin spécialisé de vente / location de vélos ❑ Salons
❑Autres, précisez :

16.Souhaitez-vous être informé lors de la commercialisation de ces différents concepts de tricycles ?
❑Oui ❑ Non

❑Par mail :
❑Par courrier :
(Nom et adresse)

FICHE D'IDENTITÉ

17.Sexe ❑ M ❑ F

18.Age
❑- de 19 ans ❑ de 30 à 49 ans
❑de 20 à 29 ans ❑ de 50 à 69 ans
❑+ de 70 ans

21. Situation de famille
❑ Célibataire ❑ Divorcé
❑ Marié ❑ Veuf
❑ Enfants

19.Catégorie socioprofessionnelle
❑Employé / Ouvrier ❑ Commerçant / Artisan ❑ Profession intermédiaire ❑ Etudiant
❑Cadre ❑ Retraité ❑ Fonctionnaire ❑ Sans emploi

Merci de votre participation !

Lieu d'administration du questionnaire :
Date:

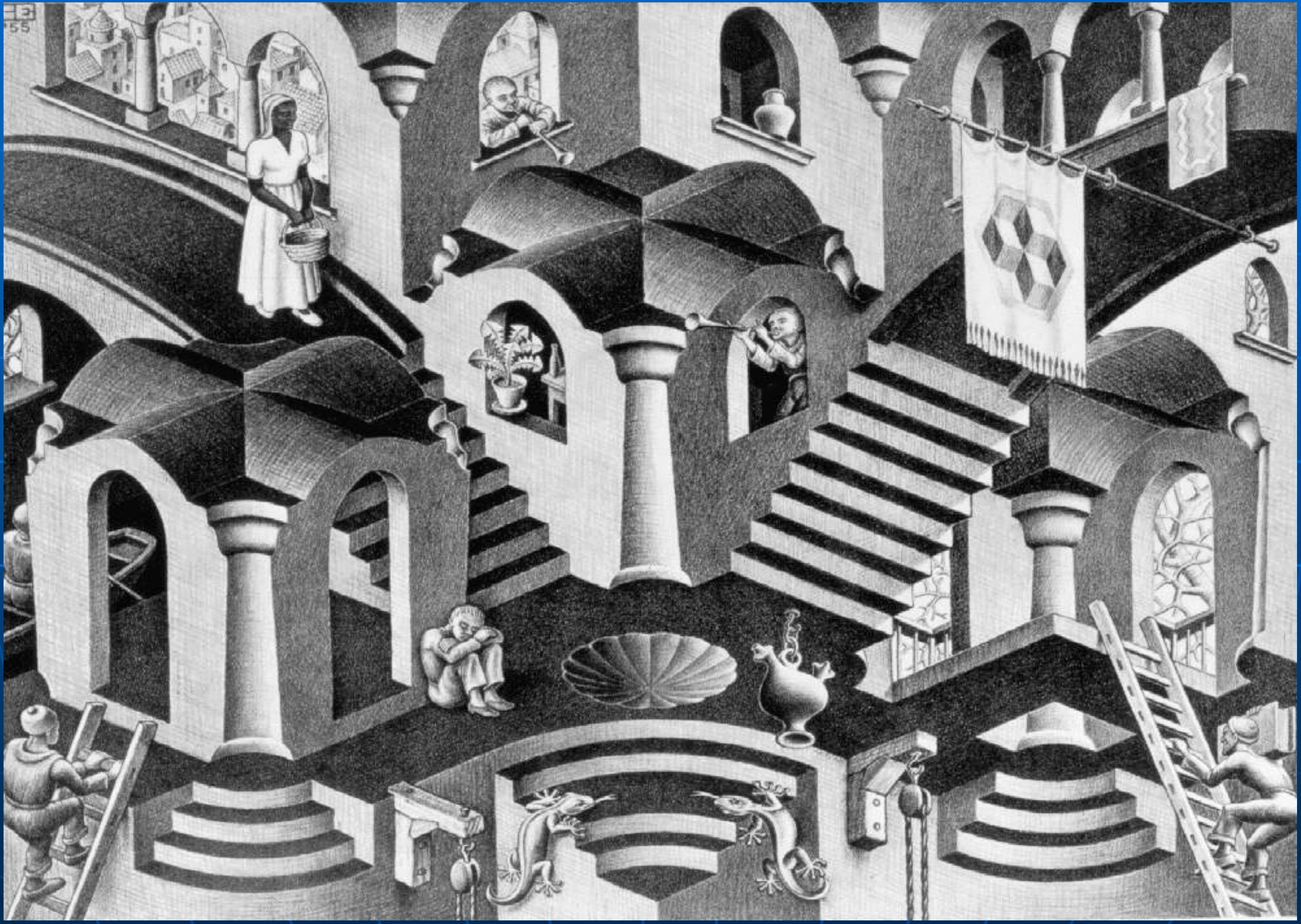
Velomobiles in traffic

- 6th Velomobile seminar
  Copenhagen
  16 october 2009

- How to improve
  your own safety

By Paulus den Boer

Is it Concave or convex



The black dia's present the spoken text

- Hello, Thank you for coming here to listen to my presentation.
- My name is Paulus den Boer and I am pleased to be able to give this talk here today.

- I am a carpenter, living and working in Zwolle, The Netherlands. I ride recumbents since the early eighties.
- The last 8 years I am mostly riding velomobiles. I use them for almost all my transports.
- In the first part of my presentation I will explain my choice for riding a velomobile and my background
- Further on I will go a bit deeper into the safety aspects of Velomobiles, especially those related to visibility: see and be seen.
- If you have questions, I would like you to keep them to the end of my talk for some discussion.

Introduction

Paulus den Boer,

Zwolle, the Netherlands.

- Carpenter
- Father (one boy-19-)
- Recumbent since 1980
- Velomobile since 2001

1) Why a velomobile
2) Safety aspects of visibility

- I used to ride to work with a car that I shared with another person. He used it in the weekend, I on working days. But when the car broke down and my mate stopped I had to make a decision: do I spend money to fix it? Or do I replace it with another car or…..
- It was a tempting moment to change all transport to cycling. But would I manage to cycle also on dark, wet and cold days?
- On an open bike you are always exposed to the elements.

From car to Velomobile

- Starting with shared car
- Broken car: alternatives
  - Fix it
  - Replace it
  - Change transport type
- Cycling distance but:
  - What about rain?
  - What about darkness?
  - What about cold?

- If you don’t want to ride an open bike, a velomobile can be the answer. The first series of velomobiles in the Netherlands was a set of 25 Alleweders made in 1992. One of these I could buy second hand. A good opportunity to see whether riding in such a thing was suiting me.
- This old Alleweder – nick named “the potato” – already had been technically updated. But due to joy-riding by a bunch of vandals, the looks where horrible. It fully deserved the name “potato”. This was not the looks I would enjoy riding in, so I decided to pimp it completely: nothing better than riding a good looking bike!

"The Potato"

- 2nd hand Alleweder
- First series but upgraded
- Looks suffered from joy-riding
- Pimping for fun

"The Potato" 2001

- With a lot of work on the body and the great help of Harry Gijsman for doing the paint work, the Potato had a total makeover making it the Appelweder, referring to the inspiration of the Dutch painter Karel Appel.
- Here you see it as it was straight after the paint job.
- The concept of riding a velomobile did suit me remarkable well . So well, that later on the Appelweder was replaced first by a second hand Quest and later twice a new Quest. Using the velomobile for almost all my transport, I drove velomobiles for over 100 thousand km so far.
- It even would have brought me here in Denmark, if I didn't have to take the train due to lack of spare time …

becomes “The Appelweder”

Inspired by the painter
Karel Appel.
Paintwork by
Harry Gijsman. & myself

Velomobile for total transport

The appelweder, 2001

- As a Velomobilist I heard repeatedly remarks about so-called poor visibility.
- These remarks are often followed by the suggestion to mount a flag and other items to raise awareness in traffic.
- It is a bit strange that riding in an object of nearly one metre wide, a metre high and more than two metres long you are not seen but with something like a flag you would.
- You are also regularly accused of being dangerous – instead of the fast moving cars that weigh far over 1000 kg
- But since I am a kind man and eager to listen to advice, I mounted a flag on my first (recumbent) bike. Until I had a similar discussion and a car-driver told me that I should have a flag…. Which I already had! So as soon as I was home again, the flag was taken of definitively.
- Thinking about flags, there are several reasons why I don't like them. But you have to decide for yourself whether you keep them or not:
- Flags make noise, a lot of noise
- Flags sweep dangerously around and you can easily imagine what happens if the flag pole hits someone in the eye
- At least in The Netherlands, flags are associated with children. This is dangerous, because children ride slow, very slow compared to me on my recumbent or in my velomobile
- It is amazing how high the drag resistance of a flag pole is. Of course you can reduce this (and the sweeping action) by taking a shorter pole, but what is then the point anyway?
- Only in a very limited number of situations you will see the flag before you see the whole bike. This means that in most circumstances, the flag only gives a false sense of visibility.

You should mount a flag!!!

So I did untill….

Flags have disadvantages:

1. It makes noise,
2. It sweeps dangerously
3. Associates with a child
4. High drag resistance
5. False sense of visibility

- Although I have removed the flag from my bike and never put one up again, other people do have a flag on their bikes. Here you see Nico van Laar in his Alleweder. But be honest: what do you see first: Nico or his flag?
- Well, I can tell you why a grumpy old man like me doesn’t like a flag or certain other safety features, but it is more interesting to learn something about the background of seeing and being seen.

What do you spot first: Nico van Laar or the Flag on his bike?

In stead of disliking certain safety features: look at this movie

Just Be Aware

Look for two minutes at this movie
Figure out: "Whodunnit"

http://www.youtube.com/watch?v=ubNF9QNEQLA

….. So, who did it??

- First time viewers
  - What changed?
  - Where?
  - When?
- Second time viewers
  - Grabbed it immediately?
- Similar experience:
  - Directions asking person switch (derren Brown)
  - Examples of fooling the brain
- You can look also http://www.youtube.com/watch?v=vBPG_OBgTWg

- So in the previous example we have seen that looking, observing and seeing are not as straight forward as you would think. But people usually find it difficult to admit that they just didn’t look well enough and they quite often hide behind some silly excuses: SMIDSY or SEP.
- A Smidsy stands for “**S**orry **M**ate, **I D**idn’t **S**ee **Y**ah” and is used after a traffic-accidents where a car driver just overlooked a motorcyclist. http://en.wikipedia.org/wiki/SMIDSY
- A Smidsy is a way of rejecting your own responsibility.
- Very related is the S.E.P. or **S**omeone **E**lses **P**roblem. Hereby the brain filters important parts of information away where it is important for the group, but not particular for the individual. http://en.wikipedia.org/wiki/Somebody_Else's_Problem

Silly excuses

- SMIDSY http://en.wikipedia.org/wiki/SMIDSY
  - S orry
  - M ate,
  - I
  - D idn't
  - S ee
  - Y ah
- SEP http://en.wikipedia.org/wiki/Somebody_Else's_Problem
  - S omeone
  - E lses
  - P roblem

- There are numerous examples like these all telling the same story: your brain is not always showing what there is to be seen.
- It is clear that although you have the impression that you have a complete picture of the world around you, in reality your brain is fooling you. You see fragments only and the brain stitches them together to make a complete picture. The brain fills all the gaps in between the real observations with what it expects to be there, not necessarily what is there. Here comes an example to make this visible

Bits and Pieces

- Fooled by your own brain.
  - Stitching a picture
  - Making up the gaps
  - Like a deaf person hearing parts of conversations
- Fractions of reality
  - Like segmented insect eyes
  - Complementing with sound and smell
  - Filling gaps from memory
- Useful behaviour, but
  - Misleading at times
  - Focus on known things only
  - Alcohol makes it worse
  - … or using a mobile phone

- Well, what is written here:…………….

- It i j t li e a deaf rson th t he rs par of a onversa ion and ill in t e bit he did not hea , but gue es w at as been sai .

- This makes more sense (I hope…..)

- It i j t   li e a deaf   rson th t he rs par of a onversa ion and ill in t e bit he did not hea , but gue es w at as been sai .

- It is just like a deaf person that hears part of a conversation and fills in the bits he did not hear, but guesses what has been said.

- People only observe fractions of reality and make a complete picture by drawing the lines between the dots. Your brain does so by adding bits from your memory, including sounds and even smells that are not actually there! People tend to see what they expect to see, ignoring bits that the brain **considers** irrelevant or can’t recognise.
- This behaviour is beneficial in general, because it makes the brain working much more efficient than if it would observe and analyse all bits of information entering from the eyes, ears and nose. But we have to know this and learn from it. It becomes misleading if important facts are incorrectly ignored. This becomes more evident while the brain tends to focus on the items it already knows, thus ignoring bits that are not recognized.
- This “filling in the gaps” happens more and more if the brain is occupied with other tasks - like talking on the mobile phone – or is working less well, for example due to tiredness or alcohol consumption.

To be or not to be

- Important phenomenon
- Eye contact is no guarantee
- Unknown makes unseen
- Risk highest in peripheral sight

- Knowing the problem > Solving the problem

- So it is not a question of increasing our absolute visibility, but to raise the awareness of other people and break the filter rules.
- I don’t have to explain that this will become more important the more the sight becomes less, due to a bright sun ahead, or rainy/foggy/dark circumstances.
- Most velomobiles are big and in bright colours. Although this helps for absolute visibility, it is limited in its effect on breaking the filter rules. The height of velomobiles is also not directly a benefit for visibility. What we need are magic tricks to maximise observation.
- We will consider some possibilities. The best way to be noticed in the peripheral view is to be seen as a moving object. Also in the rain, fog and dark surroundings. Fog especially asks for much contrast, combined with reflective parts and lights for those circumstances.
- Under all dark conditions a proper head- and taillight are obvious,
- but you can't rely heavily on it under brighter conditions, since daylight is normally too bright for the bike lights to be seen, whatever bright these are

Indeed, to be (observed)

- Don't increase visibility but:
  - Reduce filtering
  - Increase awareness
- Big isn't better
- Bright is not always better
- Lights may help
- in dark or misty conditions
- Magic required!

- grey velomobiles fade away in fog and rain

Just some examples of mono-colored Velomobiles

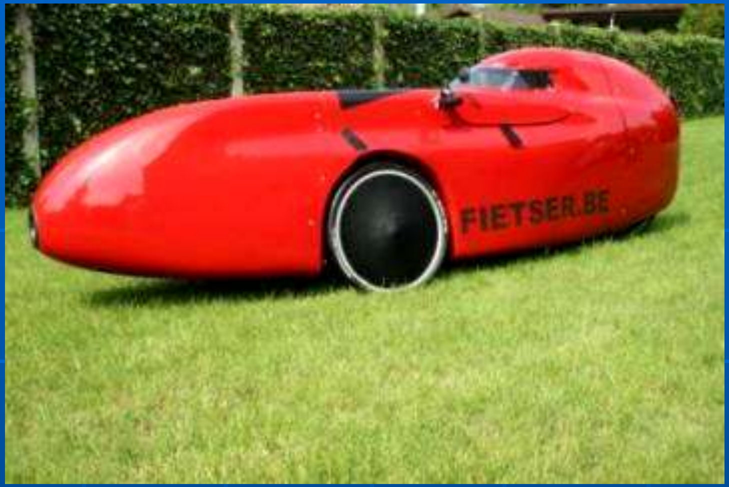
Grey mice
will disappear
soon in the dark,
fog or rain……

- white velomobiles fade away in snow

White is a good colour in nature, but with snow or fog…

- red velomobiles fade away in dark

Red fades out first in darkness



- Is Yellow the best color over all?

Yellow is used a lot

- So big and bright coloured seems not enough. Time to pimp our bikes not only for the fun of having a great looking bike, but to increase its observation profile to other people in traffic at the same time.
- There is a number of things you can do:
  - Use bright colours, but also add contrast (you'll see examples later)
  - Add reflection and use proper lights for the hours of darkness or for riding under poor visibility conditions
  - Have 2 mirrors and take control of the surroundings yourself
  - Have a good sense of humour

Pimp your bike!!

It's not absolute visibility but

-raise awareness

-break the filter rules

- Use bright colours and contrast.
- reflective parts and lights for dark circumstances. Front/tail/brake/indicators
- 2 mirrors and good sense of humour

- Falling outside the filter rules is a big part of the problem of not being seen. So if you don't want to "be filtered", make sure you fit the rules and decorate your bike in a way it triggers a "known" in the brain of the observer.
- Here is the example of Kees van Malssen's Quest 119. The characteristic black spots of a Frisian Cow makes that for a lot of people, it transforms from an unknown object (which you filter out) to "a cow" which you do actually observe. However, the English traffic scientist Ian Walker considers the simple added contrast already a big improvement and he is not sure whether the cow-resemblance makes the difference.
- In the following slides you will have several more examples of increasing awareness by pimping the bike.

Theme-velomobiles

- Reflect known objects:
- Frisian Cows gives a dramatic increase in awareness over a full white VM. (Quest 119, Kees van Malssen)

- Contrast will make a difference !!
- Here you see some examples of theme-velo’s

Contrast, contrast, contrast

- and off course a view of my theme-velo: Quesjer

Here you can see "Quesjer"

- Lots of contrast in bright colours: Traffic-yellow and traffic-blue with some reflective parts on it

- Here you can see what reflection will do in the dark, but only if there is a light-source coming from the viewer…..

Here you can see what retroreflection can do for you

- But this only will work if there is another lightsource out there

- Especially in the hours of darkness and under poor visibility conditions, lights on your bike can make a big difference.
- Lights can be divided in two categories: **to see and to be seen**.
- To see you need a proper head-light. Recently the development of high power LED headlights, in combination with well designed reflectors, has made good bike lights available to all.
- A good reflector not only maximises the available amount of light on the road, it also avoids blinding oncoming traffic.
- often these modern headlights are battery operated, but some can (only?) be powered by a dynamo as well. Some people take "being able to see" to the extreme by putting a whole string of lights on their bikes: normal head-light, extra power headlight, fog light and side-lights. Probably your batteries won't last that long if they are all lit at the same time, where one of the added benefits of the modern LED lights is their long battery life.
- To be seen you do not need that much power, but you do need them at different positions on your bike. A good head light is easily seen, as will a proper tail light. Not compulsory but very convenient is the use of indicators and brake lights. Remember that people don't expect the extreme braking power some velomobile riders apply.
- Off course, you can make a Christmas-tree from your bike but to me it seems like overkill.

- **Lights to see**
  - Modern High-power LED
  - Proper reflector
  - Battery/Dynamo-driven

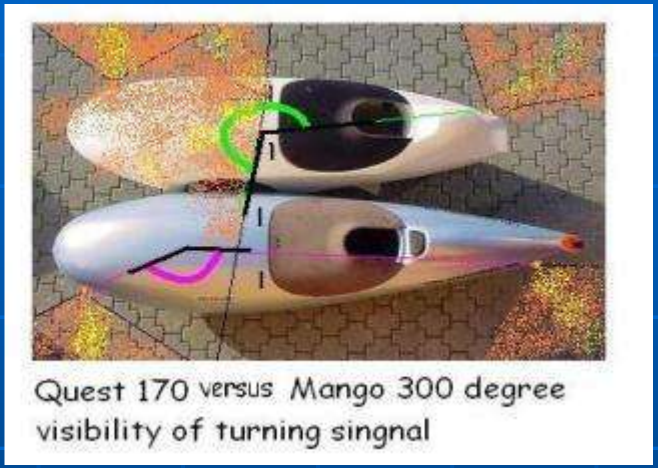
- **Ligts to be seen**
  - Headlights
  - Tail lights
  - Indicators
  - Braking lights

- headlights
-
- Just search for the light sources that enhance safety, so look carefully to the automobile-industry. Also use the expectation of traffic. (No red light pointing forward….., orange/amber indicators etc.)
- Nowadays it seems enough to implement some LED’s just squeezing out of the body-surface. A 6mm. hole will do….. For the headlight you need a proper reflector to avoid blinding, and spread the beam where you need light. Broad enough and bright enough to coop with your needs.

Lights……

- indicators
- On a normal bike you use your arm as indicator. In a nVelomobile this becomes harder to see. On a majority of modern velomobiles, therefore the indicator lights are standard or optional. Because of the combination of long lasting and low power consumption, power-LED’s are the recommended choice.
- However, these indicator lights are commonly present at the sides of the bike only. This works well for crossing traffic, but to assist oncoming and trailing traffic, I do recommend to incorporate them in the mirror-caps as well, which is a nice high point, but also serves a very wide angle which covers also the other side. This will improve the angle from roughly 170 to 300 degrees visibility. This becomes important in several traffic-situations.

Indicators



- Indicators becoming standard/optional
- Mostly side mounted
- Recommended top/mirror mounting too.

- rear and braking lights
- Even among Velomobilists head-tail-collisions do occur, especially when riding in groups. Since the driver is fully enclosed, there is no body language giving the signal (by stopping pedal-motion) that he or she will start braking. This makes a braking light essential and a safety device for group rides. It also is important in daily traffic.
- Together with Wilfred van Norel we did build those lights ourselves, based on a red Power-Led and some cheap electronics. Costs around 15 euro all together. Nowadays even standard with Velomobiel.nl.

Rear and braking-lights

- How can you see braking early?

- Enough about visibility.
- Are there other ways to make people around us aware of our presence?
  Indeed: make noise!
- On the Dutch recumbent mailinglist there has been plenty discussions dealing with this issue. What to use? A regular cycling bell? A car-horn? Your voice or some kind of electronic device?
- It is clear that some kind of noise making can actually contribute to road safety. Which to choose is difficult to say, since it depends a lot on the actual situation as well as the common culture in the country you are riding.
- So pick one (or more), but use them wisely and stay a gentleman in traffic

Beep-Beep

- Cycling bell
- Car horn
- Air Sound
- Electronic device
- Or…

- Anyway: Try to leave a smile behind you…..

- Regulations in Europe
- Carl Georg asked me to give an overview of the laws, regulations and exceptions in them comparing to velomobiles.
- This was too complex to finish now, but I'm working on it. The results will become available on internet over time at the dutch recumbent-site www.ligfiets.net : http://downloads.ligfiets.net/ligfietsnet/velomobile_rules.pdf

Compare regulations in EU

- Carl Georg asked me to give an overview of the laws, regulations and exceptions in them comparing to velomobiles.

- This was too complex to finish now, but i'm working on it. The results will become available on internet over some time at this spot:

- http://downloads.ligfiets.net/ligfietsnet/velomobile_rules.pdf

- These are ideas built upon my biking experience, mostly in The Netherlands, but also in Belgium, France, Germany, Finland and England. And of course “some” debates and discussions with fellow cyclists and car drivers.

- Now we are at the end of my presentation.

  I hope you enjoyed it.

These are just my ideas….

- Thanks
- Time for discussion
- quest212@gmail.com