

CAMERON VAN DYKE Fall 2013

A NEW FORM OF ENERGY EFFICIENT AUTONOMOUS VEHICLES

An argument in favor of lightweight human powered vehicles and an exploration of the potential legal definition for those vehicles

Introduction – New forms of transport

In a world of increasing energy costs and eventually the decline in their availability, we need to prepare ourselves with other options for mobility and productivity other than the gasoline powered car or truck. However, as Americans we are very accustomed to using “autonomous” vehicles – our whole system of roads is based on the principle of individual objects controlled by individual drivers and I do not see that changing. So what kind of autonomous “low energy” vehicles might be available to replace the car? Well the bicycle certainly provides a low energy option for mobility, but that option is severely limited by what it can carry, what weather conditions it can operate in, and more than anything else, the public’s unwillingness to embrace a vehicle that has long been considered second class. What could be done to make the bicycle more attractive? What could be done to remove some of its limitations?

Bikes are Vehicles!!

The first hurdle to making bikes a more viable transportation option is to start to see them as vehicles in the first place. Unfortunately our government tends to see bicycling as an extension of pedestrian activity – which is why biking and walking are grouped together in most national studies. In fact bicycling is not like walking and is much more of a vehicular activity. The street is a far better bicycle environment than the sidewalk. Bicycles have brakes and gears and they can go as fast as a car in certain situations. They ride on the road and are supposed to follow the same rules as the cars. A moped (which is only slightly faster than a bike and roughly the same size) is treated as a road vehicle and so should a bicycle.

The Problem with Cars – Most of the Time...

Lets talk about cars for a minute. The average new car or light truck weighs 4000 lbs. (1) As a single driver in a vehicle of that weight, the driver represents only around 4% of the total weight moved by the vehicle.... Wow, that’s inefficient! Where is all that weight coming from? Capacity. The capacity for fast acceleration, high speed travel, high speed crash protection, brakes capable of stopping a vehicle of that weight, and passenger/payload capacity. The question is - Do we need such a high capacity object for what is (most of the time) a low capacity job? As a single driver on a low speed trip around town, so much of the extra weight associated with the vehicle is unused. If I need to drive a mile and a half downtown at 30 mph to pick up tickets for the theater, why am I driving a 4000 lbs vehicle with a ½ ton payload capacity?

Weight Inflation

Now you might be thinking to yourself, “ If other cars weigh 4000 pounds, I certainly don’t want to be the one driving or riding something that weighs much less with little crash protection”. I would say in response that you are certainly on to something - as cars get bigger, other cars get bigger. Right now we have the fuel energy to power vehicles of such a large size, but if in the future we are to make more energy efficient transportation we need to reverse this trend. The truth is that cars could be much, much lighter and provide a greater level of overall safety in their use. It can be done with one simple concession – speed.

Speed

Speed is the main reason for so much of what a car is and has to be. If you want speed you need a more powerful motor which means a heavier motor and a stronger/heavier drivetrain and that means a heavier frame and more beefy brakes and so on and so forth. The inflation goes on until you have a 4000 lbs car to move a couple people. If we were to give up speed as a starting point and instead start with a lightweight, low speed, low power model, it would introduce many other possibilities. This mode of thinking would require us to question our apparent “need for speed” in the first place. Where does this modern expectation come from and is speed really of ultimate benefit to us on the roads and in our vehicles? Speed comes at a price and does the price we are paying for that speed really make economic sense? Can the word “efficiency” be thought of in terms of total energy input in all forms? What are the factors that would affect true “efficiency”? Since speed is related to time, we must ask ourselves what the value of time is and assume that people value time differently.

Bike + Car = ????

My point thus far is this - bikes provide a low energy option for mobility, but that option is limited by payload, weather conditions, and public perception. On the other hand, cars are widely accepted, but take so much energy and have too much excess capacity for most day to day around town trips. So I wonder..... could there be a middle ground between the 4000 lbs car and the 40 lbs bike? What if we could combine the lightweight/low energy attributes of a bicycle with the comforts and convenience of a car – weather protection, cargo room, visibility, and the room to take passengers? As a designer/maker I decided that I would like to try to tackle this problem and create an autonomous vehicle for myself and my wife that would combine the best attributes of a bike with the best attributes of a car for commutes around the mid size city I live in.

Bicyclemobile Design

In starting this project I knew I wanted it all – style, functionality, and features – everything I love in cars and bikes. I knew that speed was going to be the major concession. The vehicle was going to be slow, so I figured, if I am going to be spending more time travelling from place to place in this vehicle, I better love it. I also figured that if this vehicle is going to be seen on the street for greater lengths of time – I want it to be beautiful, I want it to be inspiring. Below is an image of the

completed vehicle called "Cyclone." Its monocoque structure is made of a combination of wood and EPS foam with a fiberglass hard-shell. The suspension, steering system, and pedal system are custom fabricated in steel and aluminum. All other pieces are off the shelf bicycle parts used in non-traditional ways. The acrylic windows are removable as well as the doors for added ventilation on warm days. It is pedaled by two people, each with their own set of gears to adjust to their own desired cadence. The riders power a common shaft, which sends power to each rear wheel independently by way of sprockets and chains. For the purpose of this article lets assume that I will add electrical motors to help it move at a 25mph top speed. It will likely weigh around 500 lbs for the total car including motors and battery – just 13% of the weight of a typical car.



What is in a name?

So now that I am done building a low energy Bicycle/Car that's great for the planet and will save me lots of money, now what? And what would you call this thing anyway? Lets start by exploring a few already defined potential categories.

Bicycle

The State of Michigan defines "Bicycle" as "a device propelled by human power upon which a person may ride, having either 2 or 3 wheels in a tandem or tricycle

arrangement, all of which are over 14 inches in diameter.” (2) My bicyclemobile meets those requirements - except for that pesky forth wheel. In an interview with Ann Arbor police officer Tom Kooy he stated that “It is not so much the forth wheel that would draw our attention to this vehicle, but the fact that you would be a large object, moving slowly, and probably interfering with traffic. Once we stopped you, it would be that fourth wheel that negates the vehicle as a bike, making it illegal to operate on the streets”. That was a discouraging message. I know that there are companies such as Rhodes Car and Quadracycle that make and sell large two person pedal powered 4 wheeled bikes – where are they used? It turns out for the most part that they are used in private property situations as rentals for tourists. The companies claim that some are on the road being used as daily transportation, so I was interested in finding the states that expressly allow the 4 wheeled bike or at least through the language of the law, doesn’t disallow them. There is a lot of fogginess around this issue, but through all of my research I found only one state that expressly allows 4 wheeled human powered vehicles on the road. In the summer of 2013 the State of Ohio changed their bicycle definition to include “human powered vehicles of two or more wheels.” This change was in response to a single case in Lakewood, Ohio of a man and his son being ticketed for driving a “toy car”. The Ohio Bicycle Federation got involved and pushed for the new definition. Does this solve my problem? I don’t think so, unless I want to move to Ohio.



Dominic Latessa and his homemade bicycle that changed Ohio State Law

Electric Assisted Bicycle or E-Bike

Federal Electric Bicycle Law states that the term “Low Speed Electric Bicycle” means “a two or three wheeled vehicle with fully operable pedals and an electric motor of

less than 750 watts (1h.p.) whose maximum speed on a paved level surface, when powered solely by such a motor while ridden by an operator who weighs 170 pounds, is less than 20mph.” This Federal law “shall supersede any State law or requirement with respect to low speed bicycles.” (3) The underlying message is that an electrically driven bicycle is considered a “bicycle” and not a “vehicle” if the described conditions are met. This is good news to me because except for the 4th wheel on my bike/car I can meet all of these requirements. Unfortunately as I read further I came to understand that this section is referring to low-speed electric bicycles as consumer products – in other words attempting to set a national standard for which manufactures of e-bikes could meet. Home built e-bikes are governed by state and local laws – so that puts this project back at the state level. What is Michigan’s e-bike law? In short it is a moped. “Moped” means a 2- or 3-wheeled vehicle which is equipped with a motor that does not exceed 50 cubic centimeters piston displacement, produces 2.0 brake horsepower or less, and cannot propel the vehicle at a speed greater than 30 miles per hour on a level surface. The power drive system shall not require the operator to shift gears.” (4) Clearly I am out of luck there with both the home made aspect and the forth wheel being an issue.



E bike

Low Speed Vehicle & NEV (Neighborhood Electric Vehicle).

My next option to explore is the NEV or low speed vehicle. A low speed vehicle is defined by the Michigan State Police web site as “an electrically powered vehicle

designed to be operated at a speed less than 25 mph with a capacity of no more than four occupants. They are limited to certain types of roads (35mph max). Some electric golf carts can be extensively modified and registered as low-speed vehicles, subject to the completion of a TR-54 form by a police officer". (4) The State of Michigan actually simply uses the Federal Motor Vehicle Safety Standards in defining a low speed vehicle. The law has these basic elements: *Low-speed vehicle (LSV)* means a motor vehicle, (a) That is 4-wheeled, (b) Whose speed attainable in 1 mile is more than 20 miles per hour and not more than 25 miles per hour on a paved level surface, and (c) Whose GVWR is less than 1,361 kilograms (3,000 pounds). (5) There are many additional requirements that make it as much like a car as possible: lights, signals, mirrors, glass, license plate and insurance. Closely related to the LSV is the NEV (Neighborhood Electric Vehicle). This vehicle is basically a golf cart, but with the safety and signaling abilities of a regular car – headlights, turn signals, seatbelts, windshield, etc. The maximum speed of an NEV is usually 35 mph and can travel legally on roads with a max speed limit of 45 mph. In a way this is really the 4 wheeled version of the moped, which has similar maximum speeds and safety requirements.



Neighborhood Electric Vehicle

LSV & NEV - The way forward?

Through the research it is clear that a LSV or NEV might be the way to go with my vehicle. The NEV model certainly deals with the issues of the excess capacity and

weight in cars that I spoke of earlier. In terms of around town low speed personal transportation it has many advantages. Since the NEV runs on electricity there are no emissions from the vehicle itself. There is the elimination of idling energy costs in traffic. The use of electricity as a fuel is much more efficient – especially in charging overnight. There is the savings of wear and tear on gas powered vehicles for short trips – warm up/cool down is eliminated – electric motors don't experience additional wear from short periods of use. Lastly of course the vehicle can be much lighter than a car and using much less energy.

If the NEV was adapted as a solution to around town travel, if people replaced the second car with an NEV, if cities went as far as an NEV only zone in the downtown, we would have a quieter city with better air quality and much more efficient travel. The efficiency that could be introduced into our transportation system through the adaptation of the NEV could be very significant.

Conclusion

Clearly I am going to pursue the “low speed vehicle” categorization for my bicyclemobile, it seems like the obvious choice. It may also be an obvious choice for an automobile addicted American. The way we Americans move ourselves around our built environment is not sustainable and higher gas mileage in the same vehicles is not going to solve the long-term problem. We must be more creative and gain efficiency through better technology, but far more importantly and effectively, by changing our behavior. We need to adjust our assumptions and expectations of autonomous travel. It has been so long since it was done any other way – few of us can remember or imagine it, but there are and will be other ways. My bicyclemobile is one of those ways and demonstrating the need and viability of such a vehicle is why I built it. This is the vehicle I want to ride in and I am willing to spend the currency of time to purchase that experience and demonstrate an alternative reality to those that come in contact with it.

As a society we also need to start to see time as a currency worth spending in pursuit of other benefits – traffic safety, clean air, better health, and less energy dependence. Faster! Faster! has been the approach, but have we ever questioned if speed is really all that we need?

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(2) Michigan Vehicle Code Act 300 of 1949 Section 257.4

(3) Federal Electric Bicycle Law HR 727 Section B & Section D

(4) Michigan Vehicle Code Act 300 of 1949 Section 257.32B

(4) Michigan State Police, Traffic Services Section, Field Update #21, Low Speed Veh.

(5) Federal Motor Vehicle Safety Standards 49 CFR 571.500 Low Speed Vehicles