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A VISION FOR FEATHER RAIL: SUMMARY

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Purpose

Many of the problems facing personal transportation today are due to the predominance of cars, which leads to automobile congestion and contributes to global warming. The social construction of car culture and the reliance on automobiles appear to dissuade a majority from adopting other ways to travel.

The incremental improvements made by present-day efforts will not provide enough carbon dioxide reductions recommended by scientific advice. A new mode of transportation is presented with the intent to integrate the best advantages, help the environment, alleviate congestion, and diversify peoples' choices.

Overview and Description

The advantage of a low rolling resistance is well-known in railroading and can achieve efficiencies which - still to this day - come close to that of magnetically levitated trains, with a cost many times lower.

However, the namesake suggests the vehicles are much lighter than a train. And they are; you can pick up the vehicles off the track and store them off the rail to prevent clutter.

The weight of steam engines from 100 years ago was on the order of 10^5 lbs., and today we use cars, which is down to the order of 10^3 lbs. One more improvement is necessary, and will inevitably happen: the transition to vehicles on the order of 10^1 lbs. Decreases in vehicular weight beyond this point will scale down in proportion to the human mass of 10^1 lbs. - in other words, becoming practically negligible.

The most technologically promising proposals all serve to illustrate that practical vehicular weights of the future **must** be on this order of human weight. The last weight transition in transportation is beginning to unfold.

Apart from those PRT proposals, however, is a more simple approach. A steel rail in the shape of an I-beam serves as a monorail *over* which a vehicle is supported. This vastly simplifies the approach to construction. Over crowded extant urban environments, a viaduct is constructed. However, over a rural or relatively undeveloped area, simple at-grade ("on the ground") rails are built.

Steel and concrete are all that are required to build this rail. The civil infrastructure is loaded essentially little more than pedestrian traffic, due to the light design weights of the rail, vehicles, and people combined – the sum is on the order of 10^2 lbs. per yard. For reference, the linear weight density of a railroad rail is about 120 lbs. / yd.; feather rails shall not exceed 30 lbs. / yd.

The reduced carbon intensity of making something out of steel and concrete results in a reduced time to pay back the environmental externality and costs.

Using different methods, it is possible to safely position supine aerodynamic vehicles on top of a single steel rail. The most straightforward method is to use a cantilevered wheel over the flange of the I-beam, as portrayed in Figure 2. The cantilevered wheel is coned, like a traditional train wheel, but on a much smaller scale. The self-centering ability of this wheel can be readily engineered.

The rail network allows one vehicle to merge between different lanes, as shown in Figure 3. In a fairly developed system this would happen with the aid of sensors and computerized dynamic traffic monitoring. Basically, like a freeway, you need a certain amount of space next to you that is empty for some length behind you to merge. Once that happens the vehicle sends a "merge request" to a stationary wayside sensor which verifies that the space you glanced over at is indeed empty. The computer then bends the track sideways in an elastic fashion to coincide with the next gap. The next track is also bent into that lane's shoulder space so as not to avoid any interference with the lane next to it (two lanes over).

This hints that the rail cross section has moderate torsional stiffness, low lateral bending stiffness, and very high vertical bending stiffness. There are design exceptions for highly advanced (3-D merging) systems, where you can merge literally up, down, and diagonally with this ultra-light feather rail system.

This work was motivated primarily by the rail cycling activity, as well as the book <u>Bicycling Science</u> by David Gordon Wilson. He foresaw the advent of true monorail systems for bicycles, and it is a call to action for what must be done today.

Bicycles, as well as the new transportation proposals are all on the order of 10^3 mpg equivalent, in terms of energy intensity. This system boasts the same, possibly pushing the envelope to 10^4 mpg. The justification: bicycle technologies already allow a human to be as efficient as 10^3 mpg, but electric technologies (regardless of generation source) will allow pushing the thermal efficiency to 10^4 mpg, just as it has helped automobiles weighing on the order of 10^3 lbs. jump from 10^1 to 10^2 mpg.

All vehicles will either be electric-powered (mainly) or human-powered. For human-powered vehicles, the rate of power of walking supports a speed of 30 mph. A simple rendering of a human-powered vehicle’s frame and fairing is shown in Figure 4. The supine position can be comfortable through seat design, as long as one feels as though he or she lies down on a recliner or bed.

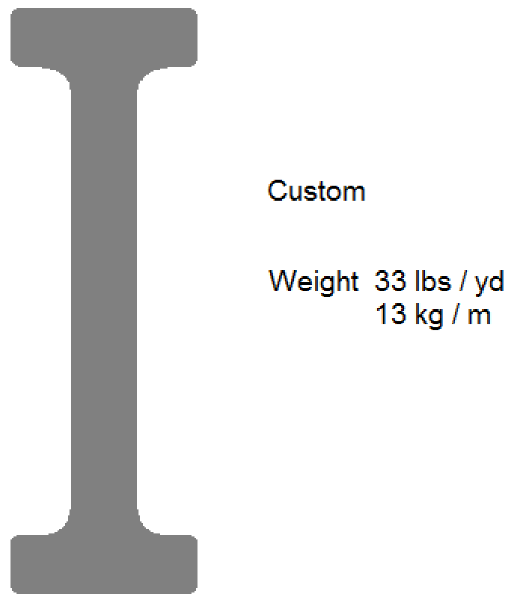

Figure 1 – Cross-section of the steel rail, with indicated linear weight density.

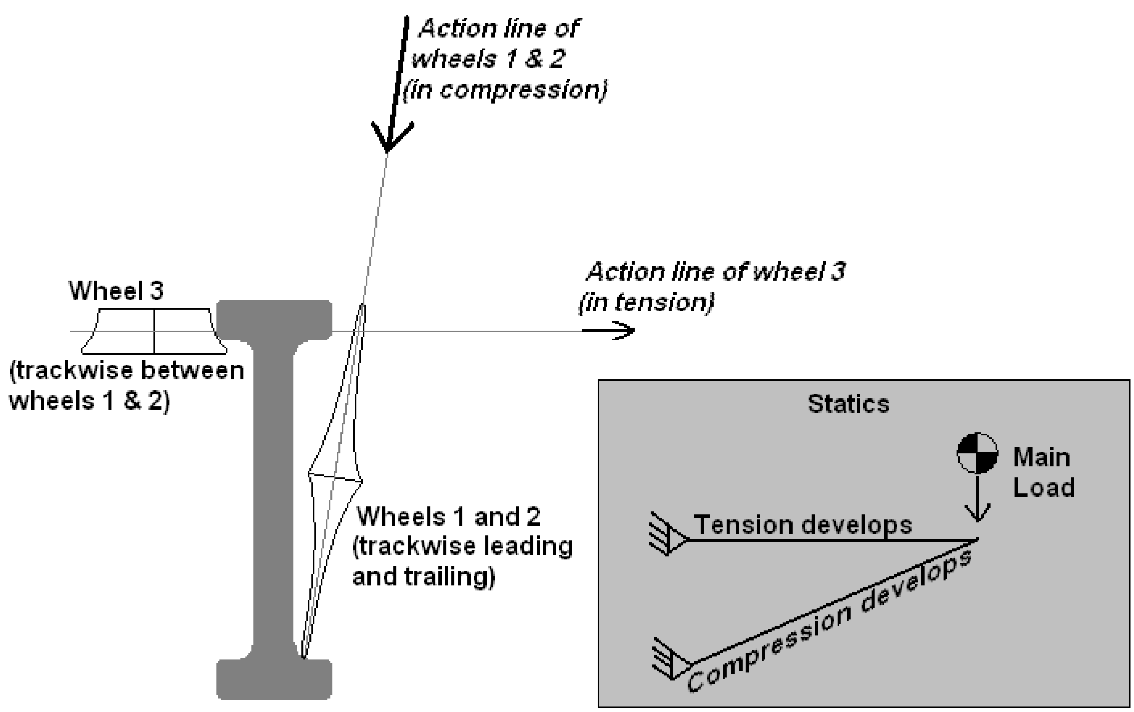

Figure 2 – The method of cantilevering for balancing a vehicle on the rail, with a truss analogue shown in inset.

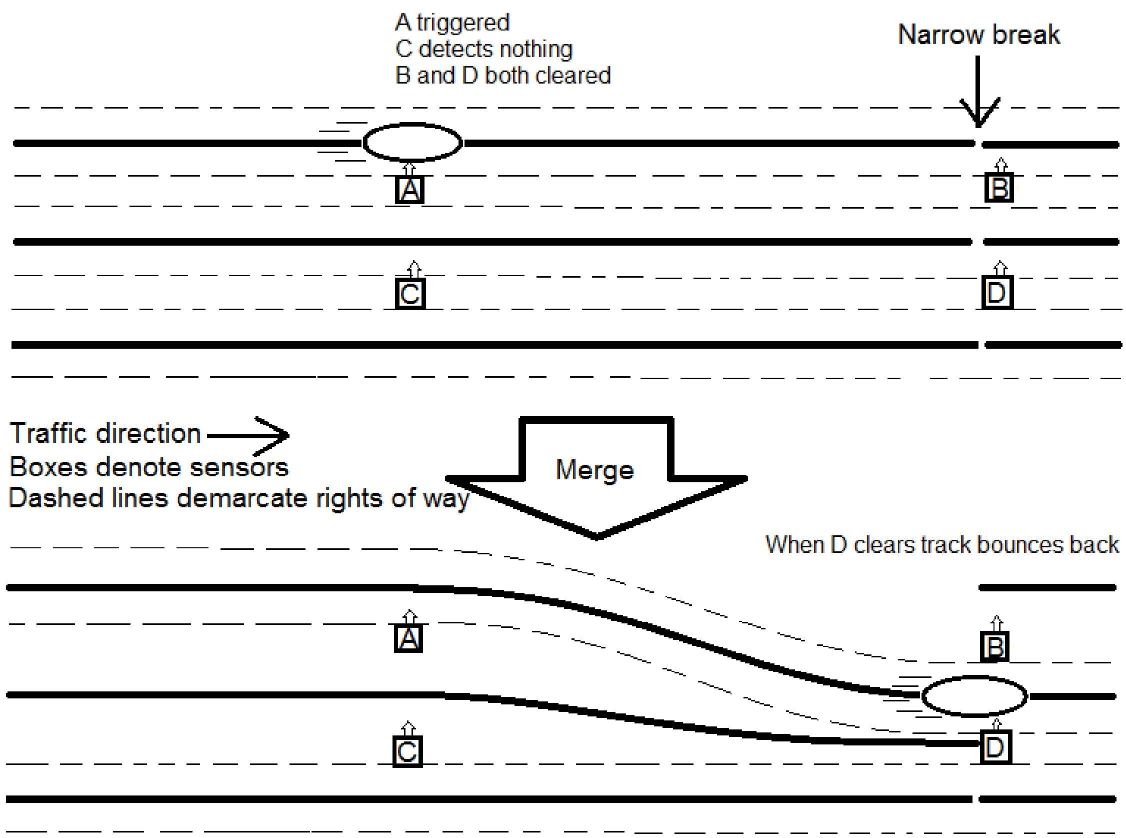

Figure 3 – Schematic of lane merging on a multi-lane feather rail line.

Figure 4 – Rendering of the frame for a feather rail vehicle.

Summary of Advantages

1. Feather rail **allows for travel on demand**, because a person can simply walk up to the nearest station platform, get his/her vehicle out of a station locker, put it on the shoulder track, and go.
2. Provided that there is adequate funding, **the system will have many convenient, nearby stations within walking distance**.
3. The effective "steering" of vehicles is provided by a merging system, **preserving the freedom to navigate** individual vehicles.
4. Recall that it is possible to balance a vehicle on a monorail. With few vehicle requirements, there are otherwise **no limits on how vehicles are designed, what they are used for, or how many people they can hold in total**.
5. The vehicles are designed to travel on average at 30 mph. **Electric and human-powered vehicles can travel at 30 mph using only the power it takes to walk.** The flow of traffic is similar to a freeway. The result: **the system will be competitive with car travel** even if its average speed is slightly slower. Congestion likelihood is minimal.
6. **The infrastructure will be cheap**, because the light weights mean that the cost to build a viaduct will be only a little more than that required to build an elevated sidewalk, due to the savings in construction material. **The rail cost is cheap,** because it is a simple cross section with 3 times less weight - and cost - than a railroad rail.
7. **A new feather rail vehicle costs about as much as the cheapest used car**. Retrofitted bicycles, which are allowed on the system, are yet cheaper still. The cost of operation is low, because money is saved (no gasoline), and electricity (for electric vehicles) is comparatively cheap. **Individuals who do not own a private vehicle can continuously use a public set for free**.
8. **The efficiency of the vehicles will be *extremely high***. The projected efficiency of a feather rail human-powered vehicle will be, in car terms, about 2,500 mpg or greater.
9. **Separated rights-of-way ensure the safety of vehicles**, and prevent relatively heavy cars and trucks from colliding with feather rail vehicles.
10. **A developed feather rail system will take a competitive amount of traffic flow, comparable to freeways and railways. Conservative estimate: 25,000 vehicles per day**.
11. Theft is generally deterred by the presence of station personnel and the presence of lockers. Safeguarding against theft is possible in a variety of other ways.
12. The noise level will be relatively low, because vehicles are extremely light and wheels are solid steel. This can reduce local opposition from building feather rail infrastructure.
13. Since the infrastructure is light and uses less material to construct, the payback time for carbon dioxide emissions involved in construction (e.g., machinery, cement production), will be quickly offset by the virtues of #8.

Practical Proposal

The authors recognize that the entire construction of a novel and unprecedented system must proceed in gradual steps, with research and development key to its realization.

The first step towards feather rail is to build a single, prototype track.

The prototype will not be fully equipped, lacking traffic lights and merges. Rather it will be a one-lane, straight track. An aerodynamic vehicle will be designed, and it is expected to perform on par with the world's most efficient vehicles, possibly breaking the world human-powered speed record of any kind. The purpose of doing this is to demonstrate the efficiency of the feather rail vehicle.

Acknowledgments

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