I'm excited about hovercraft (1/?)

published on December 6, 2021

I'm super excited about hovercraft right now. I want to build one.

During my reading session today, I finally cracked open Clarke's "Profiles of the Future"—which is a *gem!* It's what I hoped "Engines of Creation" would be (but failed to deliver): a rolling series of extrapolations about future technologies that are physically possible. All following two fantastic chapters laying into people who doubt the potential of future technologies because they haven't yet been proven out, of course. I've only really gotten through the "technology" section, where he makes it clear how not-a-fan of cars he is, proposing instead a combination of local moving sidewalks, mid-range hovercraft, and long-range VTOL or rocket travel. All founded on physical possibilities, with some economic extrapolation (why submarines or hovercraft will dominate long-range shipping, etc).

I'm most excited about the picture he paints of hovercraft (or GEMs, as he calls them: Ground Effect Machines). These craft threaten to obsolete both cars, ocean shipping, and some long-range travel. Hovering 10 feet off the ground—and being more efficient with scale—they can cruise over any flat surface: ocean, roads, plains, you name it. They have almost no limits on speed because of their frictionless air bearing, a pretty safe failure mode (at least at low speeds) by simple deflation/floating, and ultimate path flexibility. Highways would be made obsolete, or at best a convenience; casual drivers would be able to go basically anywhere they can see; ports would be made obsolete because cross-ocean freighters could just continue onto land; roadway construction and maintenance would be made much easier from the significantly lower point pressures (a "car" would have its mass evenly spread over its area, instead of it being concentrated on less than a square foot of the roadway); and so on.

Their commercial viability presents a technical and economic problem: how much does energy cost, and how much of it can you store on the vehicle? I think that the energy costs are the biggest limiting factor, from his account; he mentioned that gasoline hovercraft are already in wide use in various applications (military, remote terrain access/maintenance, etc). He essentially projects that "modern" hovercraft (1960s) won't ever become too prominent, but with the advent of dense batteries and effective electric motors, they'll start to dominate. I wonder what the limiting parameters are, and how close we are today—with battery and electric car technology—to meeting them? Certainly the dynamic would change soon with power generation like Helion's... a shipping-container-sized 20 MW fusion plant could probably serve as a decent engine for a massive freighter, right? Would it be affordable? I should do some research and calculations.

This is something right up my alley: way back in the day, I even made a primitive "hovercraft" in my parents' garage! It certainly wasn't very effective, with a ground clearance of zero (and a constant tether to corded power). But I'm at least vaguely familiar with the technology, and know the thrill of balancing on a pocket of air. Given that there's at least a small chance that consumer hovercraft would be viable with today's technology, I should look at it and see if I can build one. (Having a solid income stream helps to overcome any financial burden to experimentation, if that remains the limiting factor!) Even something with short range to drive (float?) around the roads of Corvallis could be fun.

I mean... what's the specification for that? I need to be able to go ~15 m/s, to "brake" by having powerful acceleration/deceleration fans (a sudden stop in 3 seconds = 5 m/ss), to hold myself and some groceries or Home Depot parts, to not get annihilated should some car hit me? To tolerate 6 inch bumps in the road? To have at least ~3 miles of range (safety margin)? To not be obnoxiously loud? It sounds doable, I think?

One major difference from a car is that this vehicle will very much travel in a non-steering manner: without wheels to steer the momentum, slowing will require precise acceleration opposite the velocity vector. It won't be too hard for people with video game familiarity (especially with spacecraft), but the idea of "turning"

doesn't really exist... which will be interesting. I'll have to develop some kind of spacecraft-like thrust control software, which can move me in two axes and rotate me in the third. And a few pre-specified subroutines, key of which will be "STOP" (to accelerate opposite velocity, as mentioned before). That'll require keeping track of position and velocity, too... lots of fun sensor/measurement problems.

Another difference is that there won't be many physical issues to indefinite acceleration: the only real variable there is air resistance (|v|3), without any sort of friction or heating or internal shaft pressures to worry about. I imagine that—at least on surface streets—speed will functionally be limited by acceleration potential, for emergency stopping capacity. In other words, safety will dominate physical constraints.

Which is interesting... because in theory, given that most of their energy is spent keeping themselves above the ground, hovercraft should want to go as fast as possible to be more efficient. Their maximally efficient speed will be at marginal balance of wind and time: when does it cost more to maintain a speed (fighting against air resistance) than it does to keep hovering more during the extra time it takes to not travel at that higher speed? There's an elegant formula here, and the balance depends almost exclusively on (1) how aerodynamic the craft is, (2) how efficiently it can push itself laterally, and (3) how efficiently it maintains its air cushion underneath. I don't know the precise numbers, but I would expect the balancing speed to be well above that of cars, especially for bigger vehicles. This is because air resistance scales with the cross-section, so transports can be made longer [in the dimension parallel to velocity] essentially for free; at least relative to lateral resistance. Longer vehicles will still have to hold the extra length up; I imagine effort-to-hover scales with weight and (area or perimeter)? Cross-ocean transports may well end up looking like long, thin missiles, or bullet trains, if they optimize for speed. Although... if hover-effort scales with perimeter, the extra perimeter-for-area of high-aspect-ratio shapes might cancel right back out? Lots of experimentation and math to be done here.

My brain is racing over physics and engineering problems in a way it hasn't done properly since high school robotics. I *have* to do this: to design, build, and program

a local-range hovercraft in my garage. It seems so fun, and will flex my problem-solving muscles in a non-abstract domain for once (I don't want that capacity to totally calcify)! And who knows—if the technology proves out at a non-obscene cost, there might be some commercialization potential. Even if there isn't, it'll be a great hobby for a few months 😊