Making Sense of Science

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Are We In The Future Yet?

Welcome back to the Making Sense of Science Newsletter! Thanks to all those who wrote in with insightful comments and encouragement. And a special welcome to our new subscribers (you know who you are). This week more than 350 people are receiving the newsletter!

Do you have a question about science or engineering? Ask me and your question may become the subject of a future Making Sense of Science Newsletter.

I woke up on the morning of January 1, 2000 and realized it was now The Future. The Year Two Thousand AD! Once in primary school I attempted to calculate what my age would be on that date, and wondered if I would live so long. To a kid, anything over 20 is old.

As I contemplated the new date and wondered how I would ever get used to writing it on cheques, I thought of how many amazing technological and social advances had been predicted to occur by this date. Now that we're firmly in the 21st century, where are they? Where is that wonderful machine that bathes me, dresses me, cooks my breakfast and walks the robo-dog? And where, oh where, are all the flying cars? Growing up watching The Jetsons may have created unrealistic expectations for the Future. So let's scale back those expectations just a little. Setting aside flying cars for the moment,

Where are all the electric cars?

Since 1886 when two of my favourite Germans, Gottlieb Daimler and Karl Benz, built the first motor car, the basic plan has not changed: a piston engine burning liquid hydrocarbon fuel drives a system of gears and shafts which propels a wheeled carriage containing seats. In over 120 years, that basic recipe has only been tweaked slightly. We now have CD players.

In the 1990's people like me began to imagine radically new car designs: four electric motors doubling as wheels, a bank of batteries integrated into the chassis and a tiny, hyper-efficient generator, possibly a mini gas turbine, for topping up the batteries between stops at solar filling stations. Weight, cost and complexity could be saved by the elimination of gearboxes, drive shafts, brakes, differentials and other industrial hardware.

The nearly silent car would in its essence be little more than a piece of software. To upgrade to a newer model, one simply drives past the dealer without stopping so your car can log into the dealer's wi-fi network and download the latest operating system. Why hasn't the car as we know it been made obsolete by now?

First, there's power. Comparing motors of the same weight, size and cost, electric motors are far behind internal combustion engines. To get the same output from an electric motor as one gets from a petrol engine, the electric motor generally needs to be much larger and heavier, making the rest of the car even heavier to support it. A heavier car is more sluggish and consumes more fuel.

That brings us to handling. Placing heavy electric motors inside the wheels would make the ride and handling terrible. Why is this so? Any increase in wheel mass eats away at the effectiveness of the suspension system. At the extreme limit, if the wheels weighed more than the rest of the car, bumps in the road would be amplified by the suspension instead of suppressed by it. Therefore drive axles and flexible couplings are still needed to allow the weight of the motors to be taken off the road and suspended on the car chassis.

As a result, not all of the heavy mechanical bits can be eliminated, and our imagined weight and cost savings begin to vanish like a daydream in class when the teacher wakes you with a ruler to the head. My ultimate reality check. Many of today's electric cars even have a normal

transmission, which in theory shouldn't be there at all.

Finally, there's fuel. The more your fuel weighs, the more fuel you need to lug all that heavy fuel around. Therefore "energy density" and "energy intensity," or how much energy fits into a given weight and space, are extremely important for anything that aspires to move very far under its own power.

Storing energy in the form of liquid petroleum fuel in a lightweight tank is very hard to beat in terms of cost, size, and weight for the amount of energy stored. By the numbers, nothing competes with a full tank of petrol for energy density. Not flywheels, not compressed air, not LNG, not hydrogen, not horses, nor any conceivable form of energy storage with the possible exception of solid rocket fuel (easy to start, but a bit tricky at traffic lights). Batteries don't come anywhere close. What's more, as a storage vessel batteries don't last long and need to be replaced every few years. When was the last time you had to replace the petrol tank on your car? I've only had to do it once, when I accidentally drilled a hole through it while installing a CD player on an older model that didn't come with one. Except for little mishaps like that, petrol tanks last a lifetime.

To summarize, electric cars have just as much of the old stuff plus some extra heavier, more expensive parts that don't last as long and are less efficient. We need key technological advances in the areas of energy storage and electrical propulsion before the electric car will meet even our current standards. These areas are the cutting edge of research in transportation.

But aren't electric cars better for the environment? Surprise, no! Not if you use coal-based electricity to charge up. A lighter car running on LNG even beats a heavy electric car running on wind-power once full life-cycle CO_2 emissions are taken into account. (According to some estimates, wind power is less greenhouse-intensive than solar photovoltaic energy.) Remember too that batteries are chock-a-block with toxic heavy metals that have to be disposed of or recycled every few years.

All this adds up to electric cars that simply don't deliver benefits. The limited driving range alone makes them non-starters for countries like Australia. When the performance, drivability, environmental impact and cost of electric cars meets or exceeds what we have now, only then will there be a viable alternative for driving in the future.

Regards,

John

Next time: What about running our cars on hydrogen gas instead of petroleum?

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