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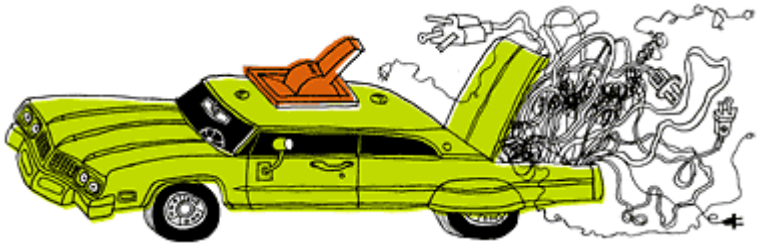
NOTES & COMMENT

Hybrid Vigor



A funny thing happened on the way to the demise of the plug-in car

by Gregg Easterbrook

NOT long ago electric cars were going to save the world. Every major automaker was developing a battery-driven vehicle that would offer both freedom from petroleum and zero emissions (at least at the tailpipe -- the power plant might be another matter). California enacted a regulation requiring the test marketing of electric cars; General Motors got there first, in 1996, with the EV1, a *Jetsons*-style plug-in coupe that was just the ticket for guilt-free commuting. And it was ... terrible.

Despite hundreds of millions of dollars' worth of research and development, GM's electric car could travel only fifty to eighty

conference of Post & Riposte.

More on **technology** in *The Atlantic Monthly* and *Atlantic Unbound.*

More on **the environment.**

From the archives:

"A Good Climate for Investment," by Ross Gelbspan (June 1998) Reducing reliance on carbon for energy -- to safeguard our atmosphere and our climate -- could bring about not personal deprivation but a worldwide economic boom.

"Mideast Oil Forever?," by Joseph J. Romm and Charles B. Curtis (April 1996) Congressional

miles before it needed a recharge, which took four to eight hours. A drive outside Los Angeles, or even to the outer valley, would have had to include a leisurely dinner followed by a three-part German opera to pass the time while the batteries recharged for the return trip. And that was assuming an excursion without air-conditioning: with the AC on, the range of the EV1 shrank further, and tractor-trailer rigs could pass it going up hills. Once word got out about this impracticality, even trend-happy Californians shunned the electric car. GM recently "suspended" production of the EV1. Honda, long the industry leader in environmental improvements, abandoned its electric-car project; other manufacturers scaled back their efforts. A few fleet buyers may still go electric -- the U.S. Postal Service, for example, which has begun buying battery-powered vans, which are practical for mail delivery because they travel short fixed routes and always return to the same point at night, making recharge expedient. But barring a fundamental breakthrough in battery chemistry, electric transportation for the masses appears as dead as a car whose headlights have been left on all night.

Yet a funny thing happened on the way to the demise of the plug-in car. Engineers realized that they could use what they'd learned about batteries and electric-coil motors to fashion half-piston, half-electric "hybrid" cars that dramatically reduce energy consumption but run in the

budget-cutters threaten to end America's leadership in new energy technologies that could generate hundreds of thousands of high-wage jobs, reduce damage to the environment, and limit our costly, dangerous dependency on oil from the unstable Persian Gulf region.

"Reinventing the Wheels," by Amory B. Lovins and L. Hunter Lovins (January 1995) New ways to design, manufacture, and sell cars can make them ten times more fuel-efficient, and at the same time safer, sportier, more beautiful and comfortable, far more durable, and probably cheaper. Here comes the biggest change

conventional way -- on petroleum from filling stations -- and never need to be plugged in. Driving range, the big drawback of electric designs, not only isn't a problem with hybrid vehicles but is significantly improved: hybrids get so many miles to a tank of gas that one could drive from New York to Washington and back without stopping. This is practical and attractive in an era of rising fuel prices. The market is about to be flooded with hybrid vehicles -- and they offer an example of the kind of serendipity that occurs when in the course of failing to achieve a planned goal, one discovers something of greater value.

* * *

Hummmmmmm goes the Honda Insight, the first hybrid car to hit the U.S. market, when the key is turned in the ignition. A piston engine has started up, but it's so small -- just three cylinders, making 67 horsepower -- that it's hard to hear. An electric engine sits in tandem with the internal-combustion unit, but it is almost inaudible. So quiet is the Insight that a check of the instrument panel is required to make sure the car is really on.

When a hybrid vehicle accelerates, the two engines run together, providing maximum horsepower; they also run simultaneously when the driver stomps on the throttle for a high-speed pass. But if the vehicle is cruising and power demand is low, only the piston engine operates. When the driver hits the brakes, the technological fun begins: the

in industrial structure since the microchip.

Elsewhere on the Web
Links to related material on other Web sites.

Hybrid Electric Vehicles
A site hosted by the United States Department of Energy's Office of Transportation Technologies. Offers directories of hybrid vehicle dealerships, related links, and general information about hybrid vehicles and the Department of Energy's partnership with Ford, GM, and Chrysler to develop such vehicles.

2001 Fuel Economy Site
A site hosted by the United States Department of Energy and the

electric motor runs in reverse, exploiting the friction of braking to generate a current that recharges a bank of batteries. The point of this arrangement is to create a vehicle that has the same basic properties as today's conventional cars but requires only a small-displacement piston engine, which burns far less gasoline. Normally, 67 horsepower would not be enough for a modern car; assisted by an electric motor, it is.

The Insight is rated by the Environmental Protection Agency at a phenomenal 61 miles per gallon in city driving and 70 mpg on the highway. Its tank holds 10.6 gallons, meaning the car can travel about 700 miles between fill-ups. For the typical driver that's one stop a month at the gas station. And the electric assist gives the car pizzazz. Humming around in an Insight, I found myself consistently able to outrun big, powerful cars. I also found that the Insight would accelerate uphill with the air-conditioning on. In a week of local driving the car got 58 miles per gallon. I know this because the Insight's instrument panel flashes a continuous readout of gas mileage.

From an engineering standpoint, what hybrid propulsion does is combine the best aspects of electric and piston motivation while avoiding their weaknesses. The weakness of batteries is "energy density." An automobile gas tank that weighs about a hundred pounds when it is full contains enough usable energy to move the typical car 200 to 300 miles; a thousand pounds or

Environmental Protection Agency that offers general information about fuel economy, vehicle comparisons and ratings, tips on gas mileage, and information about the technology of fuel efficiency.

Honda Insight
The official Honda Insight Web site. Offers general information, photos, and press reviews.

Honda Insight: Hybrid gasoline-electric car
A lengthy review of the Honda Insight with photographs and technical details, posted at Ars Technica, a site for PC hardware enthusiasts.

Longterm Road Test: Honda Insight 2000
A review and

more of chemical batteries would be needed to provide that kind of range, and there is no battery-design breakthrough on the horizon that could reduce that weight. ("Flywheel" batteries, which store power as circular motion, could in theory have roughly the same energy density as a gas tank, but making a flywheel battery practical for propulsion has stumped every engineer who has looked at the problem.) If an electric car were designed to have the driving range of a gasoline-powered car, the entire vehicle would be given over to batteries. The car would then exist to transport its own energy supply, which isn't a huge accomplishment.

The weakness of internal combustion is low thermal efficiency. Only about a quarter of the BTU value in a tank of gasoline is translated into forward motion. The rest is wasted -- lost during braking and as heat radiating from the engine. (Piston engines must be cooled or they will crack; but thermodynamically speaking, a car's radiator is a waste pump whose purpose is to discard energy.) Next time you fork over $2.00 for a gallon of gasoline, bear in mind that your car's internal-combustion engine will merrily waste $1.50 of it.

The hybrid car avoids the electric energy-density problem by having a relatively small array of batteries that provides only supplemental power. It addresses the wastefulness of the piston engine by recapturing the energy that would otherwise be lost during braking. Essentially, the

rating of the Honda Insight, by the editors of Edmunds.com, a site that provides information about automobiles for consumers.

electric coil serves as an energy recycler for the piston part. Because less energy is lost from the gasoline, less gasoline needs to be burned. Hybrid cars won't put the oil companies out of business, but they do promise to effect a significant reduction in petroleum use, coupled with a drop in greenhouse-gas emissions -- important social gains without any compromises in the way people like to drive.

* * *

The Honda Insight will not be the car that brings hybrid power to the masses. With two seats and a storage shelf, it is petite, to say the least -- it looks small enough to fit inside a standard minivan and come bursting out the way hidden supercars do at key moments in James Bond movies. Hoping for a spectacular mpg figure, Honda made the Insight extra small and held its weight to a mere 2,000 pounds (the typical midsize sedan weights about 3,500 pounds) by using an aluminum body, which is too expensive for any reasonably priced car on which the manufacturer expects to make a profit; Honda is selling the Insight at a loss. The energy analyst Amory Lovins has been saying for years that if cars were designed like aircraft, using "minimum-weight criteria," they could get much better mileage and still accelerate like the dickens (see "Reinventing the Wheels," January, 1995, *Atlantic*). The Insight is proof that Lovins is right, but also that this approach is unaffordable.

Perfecting engineering details in the Insight, however, will result in large, practical cars that, though they won't achieve 70 mpg, will represent a substantial improvement over today's vehicles. As you read this, Toyota is bringing to the U.S. market a compact four-door hybrid sedan called the Prius, which is already selling well in Japan. The Prius has a conventional steel body weighing 2,800 pounds, yet it achieves about 50 mpg in real-world driving conditions. This figure is roughly twice the current average for new U.S. vehicles, and suggests that a full-size hybrid car could achieve 40 mpg. Further, Ford is preparing to market a hybrid sport utility vehicle, GM has hybrid pickup trucks in preparation, and Dodge is gearing up to offer its gargantuan Durango SUV with hybrid power. The world will not beat a path to a teeny two-seat hybrid. But a full-size car that gets 40 miles per gallon? A minivan or an SUV that gets 30 miles per gallon? These could be huge hits in the marketplace, reversing the trends in petroleum consumption and greenhouse-gas emissions. In the end hybrid power may prove a better idea than the electric car, because it will appeal to everyone.

That failed electric-car projects have led to the invention of highly desirable hybrid propulsion serves as another reminder that what you find may be better than what you sought.

When Alexander Fleming discovered

penicillin, he was trying to perfect an antiseptic formula based on nasal mucus. No one cares that his original goal was never met -- and some may be relieved. Walter Alvarez was attempting to figure out the geologic origin of Italy's Apennine Mountains when he came across the evidence that dinosaurs had been rendered extinct by a large comet or asteroid; his intended study objective was quickly cast aside. Teflon was found by chemists who were trying to invent an alternative form of Freon; rayon and nylon were first fashioned by mistake; many cancer drugs have been discovered through serendipity.

Gresham's Law holds that bad ideas drive out the good. Sometimes a bad idea points the way to a good one.

Gregg Easterbrook is a contributing editor of *The Atlantic* and a senior editor of both *The New Republic* and Beliefnet.com.

Illustration by Kandy Littrell.

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