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'Batteries Are the Key'

With hybrids and electric cars all the rage, manufacturers are scrambling to develop a battery that can power cars efficiently and safely.

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Whoever killed the electric car is now trying to resuscitate it. As rising oil prices push drivers away from SUVs and toward hybrids, it's suddenly become apparent to consumer and manufacturers alike that the ultimate green car is one with that can run on batteries. But battery technology is stubbornly limited. Car manufacturers are scrambling for ways of eking more capacity out of batteries as well as making them smaller, more reliable and quicker to recharge. Newsweek's Andrew Bast spoke with Donald G. Hillebrand, the director of the Center for Transportation research at Argonne National Laboratory and one of the foremost experts on batteries, about how the battery in your cell phone may be the key to a new generation of alternatively powered vehicles. Excerpts:

Bast: How have batteries evolved over the ages?
Hillebrand: Lead-acid batteries have been "it" for a very long time. They're stable, they're cheap. The nickel-cadmium battery was introduced in the 1970s. They're small batteries that people used but never really seriously considered for automobiles because cadmium is so toxic. In the 1980s, there was a breakthrough, when the U.S. Department of Energy Program came up with the nickel metal hydride batteries now widely used in hybrid vehicles. It had better energy capacity than lead acid, was a lot lighter, [was long lasting] and didn't include the same type of toxic lead that everyone began to get concerned about in the 1980s. There was really no immediate application for it and the rights to it were sold overseas, mostly to Japanese companies, and right now Panasonic owns a big piece of that. They began manufacturing them for personal electronics and then very quickly when the hybrid vehicles came out in the mid 1990s, it was the perfect battery for that.

With a new generation of alternative energy vehicles, it seems that batteries are the big, missing piece of the puzzle today.
The battery is the single key. I was at a conference in Tokyo a couple years ago and the people there got it immediately that the battery was key to hybrid competitiveness, and hybrid competitiveness was key to the future of the automotive industry. That's a big statement and most people I've talked to fully agree that that is actually the case. We're in the middle of a breakthrough with lithium ion [batteries] right now, because we really don't know what the solution is going to be for the replacement of nickel metal hydride batteries.

What do lithium ion batteries offer?
If you look at your periodic table [of the elements], there are only two elements lighter than lithium: helium and hydrogen. So theoretically, you've got the best energy density because you have got such a light element that has such a good energy capacity. Lithium ion batteries have been in development seriously for about ten years. Right now you're seeing them in laptops and cell phones, but you haven't got to where you can scale them up in a big way and make them actually work in cars. There are a handful of prototype batteries that are working. We've got a bunch of them in our lab right now that we are testing for working in vehicles, but no single lithium ion battery really meets all of the needs and all of the challenges of a big automotive battery, of a big energy battery.

Why can't anyone scale it up?
The automotive environment is different than small electronics. The cost isn't really scalable when you get to automotive scales. And the other problem is manufacturing: you can make them in small, single cells, but when you start to combine the cells together, that's when you get to the point where you have safety risks with explosions. There are really five main challenges with respect to lithium ion. Almost in order they are: cost, safety, manufacturing, life and warranty.

If I were to point at the "next big thing," is the lithium ion battery going to be it?
It's going to be lithium ion alone or lithium ion in something. And we're not really sure yet. Lithium is fundamental, but will they have to put something special on it like another type of battery? Or will they have to couple it, which is something we're working on right now, to make the lithium more acceptable? That's an unknown.

What are the most significant developments out there?
Lithium ion phosphate. Lithium ion phosphate is the technology that just came out a couple of years ago from MIT. It's a rapidly growing chemistry that everybody sees as a much better option. It's just a different material for its cathode. It gets rid of the cobalt, gets rid of the nickel. It's stable, it has really high state of charges, it's safer, but it has lower energy.

Are these developments directly related to high oil and gas prices, to consumers having a bigger interest in alternative energy cars?
That's part of it. I think what's really driving it is cell phones. As they get smaller and smaller, cell phones are driving really good research on the chemistries. That has rippled through the rest of the community. Oil prices help right now, and we're all seeing this opportunity to scale-up because the battery company that gets the first real order in lithium ion from an auto maker, they've won the lottery.

Is the infrastructure there? Are there companies that are going to be able to provide these batteries in that quantity?
Manufacturing of lithium ion is a big unknown. All of the sites for that, for the manufacturing of those batteries, are overseas right now. They are not in North America and they're not in Europe either. The capacity does not exist yet but it will. A123Systems is betting on building its batteries in China and that's where we've been told their battery factories are going up right now. Korea and Japan are both planning to manufacture those batteries because they have a great manufacturing infrastructure in place already. To make a lithium ion battery you've got to hold it to really tight tolerances. You have a lot of thin metal plates that have to be kept very close without touching. You have to use an ultra pure environment. You have to be very careful with your welding and your fixing, because if any of these plates touch each other or if there are any shorts within the battery pack, you can cause a thermal concentration that will quickly blow into a flame.

How big are the batteries?
Forty miles worth of battery is about the size of an air-conditioning unit that hangs in a window. It weighs about 300 pounds. And then the batteries in a 10-mile plug-in hybrid would be about twice the size of a computer case. Keep in mind that these batteries, when you are looking at nickel metal hydride, get five to 10 percent smaller with every generation. Which is about two years. The batteries are going to continue to get smaller and better and safer. At the same time, you're going to read in the press in the next year all of the phenomenal, terrible battery fires someplace-

Fires, really?
Yes, because it's going to happen. It always happens. Did you know that one out of 1,000 cars ends up burning?

You mean gasoline fuel cars?
Yes, just any car. And there are going to be cars with this new energy technology in them that are going to burn, and as you start to see photographs on the web of laptops that burst into flames in different places, that's going to happen with cars, on occasion. And it won't be anything out of the routine, but it's something that people are going to have get used to and get ready for. But with these batteries, they will make them safe, they will give them warranties and they will make them last for the life of the car because [car manufacturers] can't face the risks of anything but that.

So, what does the future look like?
General Motors has announced that they are going to have a[n electric] vehicle in 2010 [the Volt].

Even if it's a small-scale vehicle, the amount of batteries they are going to need will dwarf any batteries produced up to this point in the world. They have said they are going to have a plug-in hybrid and every company that they have announced they're doing exploratory research with is a lithium ion company.

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