

Sidebar: Battery Research: Too Little, Too Late?

Robert Mitchell

January 10, 2005 (Computerworld) -- The power gap between current needs and what batteries can deliver for electronics today reflects a decision made years ago to all but abandon basic battery research in favor of more flashy fuel-cell technology, says **Donald Sadoway**, a battery expert and professor of materials engineering at MIT. "All the agencies in Washington said summarily, 'We're out of battery research,'" he says.

"Fuel cells grabbed the money," but basic battery research was ignored for years before that as well, says Rob Enderle, an analyst at Enderle Group in San Jose. As a result, today's batteries remain relatively inefficient.

How much can be gained by using alternative chemistries remains unclear, but Sadoway has some ideas. *Computerworld's* Robert L. Mitchell asked him about the state of the industry, what makes for good research and what the next big battery breakthrough might be.

Why is there a need for more basic battery research? The whole question of batteries is deceptive. It looks to the unschooled as relatively simple. It's a couple hundred years old, yet it's incredibly complex. We don't understand all the scaling laws or why things fail in service. In real-world apps, there are events that occur that are very difficult to model at this stage.

In some respects, the area of battery research has not been addressed enough at the fundamental level. Only in the past 10 years have the principles of fundamental materials science been applied.



Donald Sadoway, a battery expert and professor of materials engineering at MIT

I think somewhere around the mid-'90s - that's when laptop computers started to become commonplace -- it was then that we started to abandon battery research for fuel cells. The momentum for battery research was broken in part because people lost their commitment.

What is the goal -- the perfect battery? The ideal battery is a big anode and a big cathode separated by a vanishingly thin electrolyte.

Are there more gains to be had from lithium ion? I think that lithium ion can be pushed a little bit harder with electrode materials -- for the cathode in particular. There may be untapped capacity in certain materials that could dramatically improve the amount of energy storage in the battery by improving the cathode. I have cells operating at about 300 watts per kilogram, which is double what lithium ion is doing today. I think there's plenty of room at the top here. We're not banging up against the ceiling yet.

Where will the next big leap come from? Solid-state batteries. We think the next improvement will come from eliminating any liquid from the battery. We think that there are opportunities for looking at multilayer thin-film laminate with no liquid, a polymer as the electrolyte separator. You're looking at something that's similar to a potato chip bag, a polymer web coated with a different layer of chemistry. We can make that by the square mile -- it's not difficult to do. We're talking about a doubling or tripling of the capacity of today's batteries, as opposed to a 20% or 30% improvement.

Are there other benefits to solid-state design?

The need for safety. A lot of the problems in advanced lithium ion batteries derive from the fact that you have an organic liquid. Lithium ion is not water-based. It's an organic liquid like an alcohol. It's flammable. If it gets hot, the pressure increases, and you'll break the case. It could catch fire. If we go with a polymer electrolyte, you don't have any liquid; it's inert when it comes to heat, plus you can shape it. Look at a polymer bag. If we could make a battery in that mode, we could have something that if you puncture it, nothing can leak.

Will it work in the real world? Many battery experiments in the lab never make it into production. We've been mindful of that. People are starting to realize that there is no point going on a path that's always going to be consigned to the realm of laboratory curiosity. We've been thinking about costs as well. That said, we think there are opportunities looking at [solid-state batteries].

When we stop thinking about what's gee-whiz in the lab, we cease to invent. Invention is what gives us new tools. That's why we have to retreat to the fundamentals. If you have one- or two-year planning horizons, you're not going to invent.

Research funding has not been freewheeling enough. It's been too tight on a leash, expecting instant results, and there are consequences.

How would you like to see research priorities change? Over the past years, there has been a loss of people doing battery research. A lot of those people have left. There is nobody producing lithium ion batteries in the U.S. There are a number of start-up companies, but in terms of mainstream batteries that go into PDAs, cell phones, laptops, I defy you to show me a battery that says, "Made in the USA." All of the lithium technology has gone to Asia. Meanwhile, the U.S. military needs lithium chemistry. Are they going to buy it from China? Things are really cockeyed.

The overarching theme is balance. We're out of balance right now. What happens in the university sector is that you get an injection of funding, you draw new people in and get new ideas. When the funding dries up, people leave, and it's not like a water faucet, you can't just turn it back on. We have a few pockets of excellence, but compared to the magnitude of the problem, we've got far too few people in areas pertaining to energy and the environment.

There's a lot of work in Japan and Korea. It's fair to say that industry in East Asia is starting to make investments in its universities. They're starting to do things between companies and universities that we do between companies and suppliers, which is build long-term relationships. The professors being funded know they can take radical innovations.