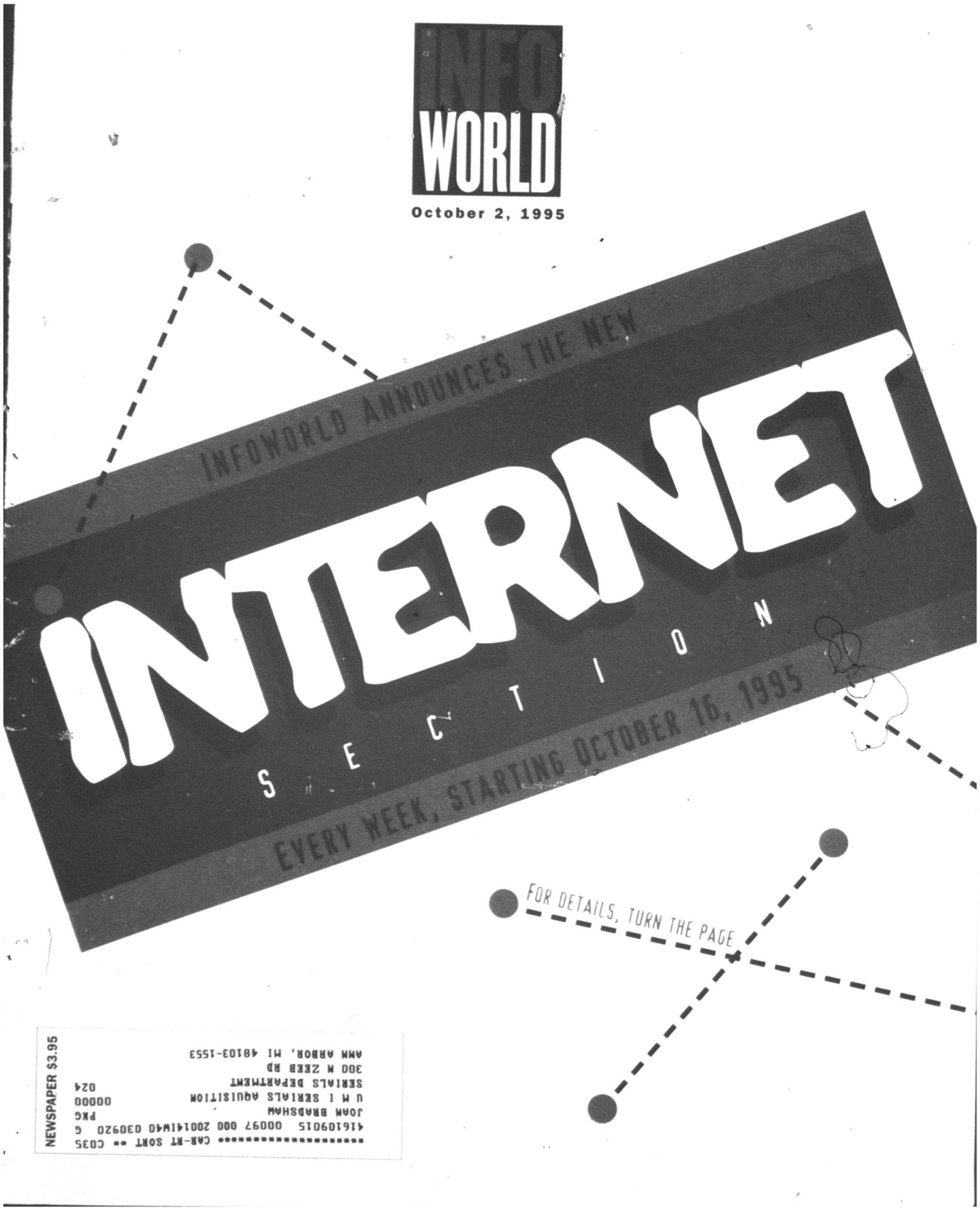


NEW BATTERY TECHNOLOGIES MIX BRAINS AND CHEMISTRY

By Anita Epler and Ross Owens

As the personal computer pendulum swings from desktops to notebooks and an increased proportion of the country's workforce goes mobile, the rechargeable battery market has become one of the biggest beneficiaries. Even so, the typical rechargeable notebook lacks even the longevity to survive a cross-country plane trip.

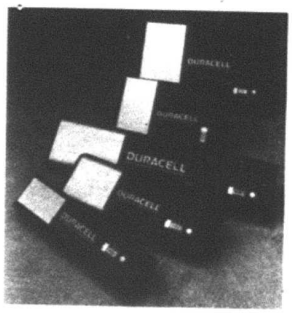
Alas, it seems that along with each incremental improvement in battery efficiency has come a dramatic jump in the burden a battery must endure. Power-saving features and modest gains in a battery's energy density have been answered by color screens, larger storage capacities, and other enhancements that put further strain on an already beleaguered battery. Luckily, new long-life battery technologies and proposed "smart" battery standards could change the way we think about portable computing.

BATTERY BASICS. Versatility, seniority, and low price are what have historically made nickel-cadmium (NiCad) batteries the dominant force in the rechargeable battery market. Introduced in the 1960s, NiCads can be found in power tools, pocket radios, camcorders, and household appliances. In 1994, they accounted for roughly 30 percent of all portable PC batteries, but by 1996, analysts estimate their presence will be statistically insignificant.

Once the darling of portable PC vendors, NiCad has fallen out of favor for a number of reasons. Compared with emerging battery types, NiCad packs are relative wimps — they offer at least 20 percent less volumetric energy density (energy vs. size) than competing technologies. Even more pressing in this era of "green" concerns, NiCads rely on cadmium, a potentially hazardous material. Those vendors that still use NiCads are generally attracted by their low price and proven track record.

Brought to market in the late 1980s, nickel-metal-hydride (NiMH) is the technology of choice for portable batteries, at least for the time being. According to research from Dataquest Inc., NiMH will account for 64 percent of notebook power packs in 1996. But by 1998, analysts predict NiMH batteries will drop to minority status, accounting for 40 percent of the market.

Why is a relatively new technology heading so rapidly toward extinction? First, NiMH battery production is an expensive process. For the extra cost NiMH fabrication incurs, its benefits are a little disappointing. Although the batteries offer an energy density 20 percent higher than NiCad's, the net effect on your notebook's longevity may be as little as 30 minutes. And although nickel-metal-hydride isn't dogged by the environmental drawbacks of NiCad, NiMH is plagued by its own shortcomings, including a rapid self-discharge rate, a high sensitivity to both heat and cold, and susceptibility to the so-called memory effect.



Duracell hopes to promote its standard-size batteries on the coattails of new bus and data specifications.

NEW AND IMPROVED. Another prime reason for NiMH's decline is the emergence of lithium ion batteries. Because lithium is a relatively lightweight element, these power-packed cells deliver about 50 percent more power than NiMH batteries by volume, and nearly 80 percent more energy by weight.

On the downside, lithium is a highly volatile element. Early lithium batteries were plagued by horror stories about fires and explosions; NEC Technologies Inc. had to recall lithium-powered portables in the late 1980s. Although current designs reportedly rely on a less-volatile chemistry, the anecdotal stories of exploding batteries still circulate in the industry, like a bad urban legend that refuses to die.

Despite their bad rap, lithium ion batteries have caught on fast. Half of the high-end systems in this comparison make use of the newer battery type, and their life spans show it. On average, the lithium-based systems we compared lasted more than twice as long as their NiMH-based competitors (see chart, page 76).

ON THE HORIZON. But even rising stars such as lithium ion are eventually eclipsed by newer competitors. Two new types of power sources have been in development for years and are poised to enter the portable computer market.

The first technology that could give lithium ion a run for its money is zinc-air. Compared with NiMH, zinc-air cells have two to three times the energy density by weight, but because they require more airflow to operate, their power-by-volume rating lags behind other technologies. The result: bulky but lightweight cells.

AER Energy Resources Inc. has developed a zinc-air external battery for use with major vendors' systems. (See "Portable PC batteries will last longer by '95," April 4, 1994, page 29.) The vendor estimates these platelike accessories can power a typical notebook for 10 to 15 hours per charge. And, because zinc-air cells aren't vulnerable to memory effects, they can be recharged midcycle with no penalty.

Further down the road, manufacturers may turn to lithium-polymer batteries. They offer roughly twice the energy density as lithium ion cells and one extremely useful benefit: flexibility. Because they're polymer based, not liquid, these cells are essentially a sandwich of metal meshes that can fit into virtually any shape. Designers can worry about all the other components first, and then — theoretically — cram the

▸ *For news of a recent lithium ion battery recall, see "Apple bruised by supply shortages, faulty PowerBooks," Sept. 25, page 53.*

Features and system design

Hefty Pentium notebooks come packed with features

These systems set a new standard for portable system design; many offer infrared ports and sound capability in addition to standard features. Unfortunately, some pay the price in added girth or cost.

	IBM ThinkPad 755CX	TI TravelMate 5000	Zeos Meridian 850C	Aspen Aspenta 90	Dell Latitude XPi P90T	Sceptre SoundX Pentium Gold Series
Dimensions in inches[1]	11.7 by 8.3 by 2	11 by 8.5 by 2	11.6 by 8.8 by 2	11.3 by 9.5 by 2	11 by 8.75 by 2.27	11 by 8.5 by 2.4
Weight (system, battery, and modem only)	6 lbs., 1.4 oz.	6 lbs., 13.7 oz.	6 lbs., 15.5 oz.	7 lbs., 7.2 oz.	6 lbs., 4 oz.	6 lbs., 13.9 oz.
Weight (as above, plus power supply)	7 lbs., 0.05 oz.	7 lbs., 3.3 oz.	7 lbs., 11.6 oz.	8 lbs., 15.5 oz.	7 lbs., 2.6 oz.	7 lbs., 10.9 oz.
Battery type	Lithium ion	Lithium ion	Nickel-metal-hydride	Nickel-metal-hydride	Lithium ion	Nickel-metal-hydride
Built-in mouse port	Yes	Yes	Yes	No	Yes	Yes
Keyboard port	No	Yes	Yes	Yes	Yes	Yes
Infrared port	Yes	Yes	No	No	No	Yes
Sound and microphone ports	Yes	Yes	Yes	Yes	No	Yes
Built-in modem	Yes	No	No	No	No	No
Simultaneous use of screen and external monitor	Yes	Yes	Yes	Yes	Yes	Yes
Screen type	Active	Active	Dual-scan passive	Dual-scan passive	Active	Active
Screen size in inches	10.4	10.3	10.3	10.3	10.4	10.4
Video type	Local bus	PCI	Local bus	Local bus	Local bus	PCI
View indicator lights with lid closed	Yes	Yes	Yes	Yes	Yes	No
Built-in pointing device	Pointing stick	Pointing stick	Pointing stick	Trackball	Trackball	Trackball
System design score	Excellent	Excellent	Excellent	Very Good	Very Good	Poor
List price	$6,670	N/A[2]	$3,895	$3,320	$5,597	$4,999
Street price[3]	$6,670[4]	$5,145	$3,895[4]	$3,320[4]	$5,597[4]	$4,350
Price score	Poor	Satisfactory	Very Good	Very Good	Satisfactory	Good

1. Length by depth by height.
2. Texas Instruments does not supply a list price or suggested retail price.
3. Priced by *InfoWorld*'s research department on Aug. 28.
4. Same as list price; direct from vendor.

INFRARED: THE JURY'S STILL OUT

Although infrared ports seem to make a lot of sense for synchronizing files and printing documents, the technology simply hasn't taken the desktop world by storm. Our readers say wireless capability isn't all that important to them, ranking it below even luxuries such as integrated sound and CD-ROM drives.

PRODUCT COMPARISON

over, or spread a very thin battery along the entire bottom edge of the case.

Although many manufacturers, including Dell Computer Corp., are investigating the use of the polymer batteries in portable PCs, initial use has been limited to cellular phones.

STANDARDS GALORE. Although most systems today offer some form of advanced power management to balance operating time against performance, new smart-battery technology takes this idea one step further. Using embedded microprocessors, smart batteries and charging systems can extend usable life by as much as 20 percent, without any changes in chemistry.

Smart batteries themselves aren't all that revolutionary. First introduced in 1993, they're already appearing in major vendors' systems. But two new standards — backed by Intel Corp. and Duracell International Inc. (the consumer battery giant) — could make this technology easy and affordable even for relatively small manufacturers.

The System Management Bus (SMBus) standard will specify a two-wire battery interface, responsible for transmitting clock signals, data, and instructions to a battery or charger.

It's an open specification, allowing for communication to take place independent of battery-specific issues such as voltage, chemistry, capacity, or form factor. The SMBus has the potential to reduce costs by eliminating proprietary connections and other costly components.

The second proposed standard — known as Smart Battery Data, or SBD — defines the protocol used to transport information from embedded electronics in the battery via the SMBus. Systems will be capable of accessing battery information such as chemistry and capacity data, current charge and predicted discharge rates, and error messages, all via a generic set of commands.

In addition to advancing the SMBus and SBD standards, Duracell is pushing for standard battery sizing, similar to alkaline batteries' letter designations (A, AA, C, D, and so on).

Considering the intrinsically mobile nature of the rechargeable battery market, Duracell may be on to something. Rather than buying replacement batteries from a single vendor source, a user could pop into a local computer superstore and buy a replacement battery at any time, in any major city.

Although some vendors oppose this concept, citing a lack of flexibility in design, many OEMs — including Canon Computer Systems Inc., Compaq Computer Corp., and others — are designing systems and peripherals around these standard-size cells.

Most of these new developments will take a while to trickle down to mainstream use, but they're certain to change the face of portable computing in the months and years to come.

WIN95 INTRO BLUES?

Although there's no objective way for us to measure stress, many of the technical support teams we called during this comparison seemed tired and overworked. We called during the week of Aug. 24 and a few weeks thereafter. Coincidence? Perhaps.

FILL 'ER UP

Today's battery "fuel gauges" give only a rough indication of the remaining operating time and can sound an alarm or force a shutdown with as much as 20 percent of usable capacity remaining. In contrast, smart battery readings will be accurate to within 1 percent or 2 percent and will allow users to work almost right down to their battery's last volt.

Battery-related terms

Cycle: The process of one complete battery discharge and recharge.

Cycle life: Useful life of a rechargeable battery, expressed as the total number of discharges and recharges.

Discharge rate: The rate (expressed in amperes) at which electrical current is withdrawn from the battery.

Energy density: The amount of energy available from a battery, expressed in watt-hours per kilogram (gravimetric) or watt-hours per liter (volumetric).

Memory effect: The gradual shortening of a battery's useful life, caused by recharging before the battery is completely discharged.

Run time: The amount of time a battery will operate a specific product before depleting the entire charge (otherwise known as full depth of discharge).

Self-discharge: When internal chemical reactions (such as the drying out of chemicals) cause the loss of useful capacity of a cell or battery in storage.

Service life: The length of time a battery should provide useful levels of current and voltage when activated.

Shelf life: The amount of time a battery can be stored under specified conditions and still retain a useful charge.

Smart battery: A rechargeable battery equipped with a microchip that collects and communicates present, calculated, and predicted battery information to a notebook computer or cellular phone.

Smart Battery Data (SBD): The information accessible across the System Management Bus between the smart battery and the device.

System Management Bus (SMBus): A serial bus that provides the pathway for Smart Battery Data communications.

Support policies

A case of 'haves' and 'have nots'

We're glad to see that major vendors now consider all-hours support the norm — good news for the increasing number of workers who burn the midnight oil. Second-tier suppliers still cling to minimal support policies, though, including meager electronic access, business-hours-only phone support, and no free on-site service. Sceptre even skimps on a money-back guarantee

	75-MHZ SYSTEMS			90-MHZ SYSTEMS		
	IBM ThinkPad 755CX	TI TravelMate 5000	Zeos Meridian 850C	Aspen Aspenta 90	Dell Latitude XPi P90T	Sceptre SoundX Pentium Gold Series
Free telephone support	Yes	Yes	Yes	Yes	Yes	Yes
Telephone support hours*	24 hours per day, 7 days per week	24 hours per day, 7 days per week	24 hours per day, 7 days per week	Weekdays 9 a.m. to 6 p.m., Saturday 10 a.m. to 2 p.m. ET	24 hours per day, 7 days per week	Weekdays 8:30 a.m. to 5:30 p.m. PT
Warranty period (parts and labor)	3 years	3 years	1 year	1 year parts, 2 years labor	3 years parts, 1 year labor	3 years
Free on-site service	3 years	No	No	No	1 year	No
Money-back guarantee	30 days	30 days	30 days	30 days	30 days	None
On-line support	In-house BBS, CompuServe, Internet	In-house BBS, CompuServe, America Online, Internet	In-house BBS, CompuServe, America Online, Prodigy, Internet	Internet	In-house BBS, CompuServe, America Online, Prodigy, Internet	In-house BBS
Fax-back support	Yes	Yes	Yes	Yes	Yes	Yes
Support policies score	Excellent	Very Good	Good	Satisfactory	Excellent	Satisfactory
Technical support score	Good	Satisfactory	Good	Very Good	Good	Good

*ET = Eastern time; PT = Pacific time

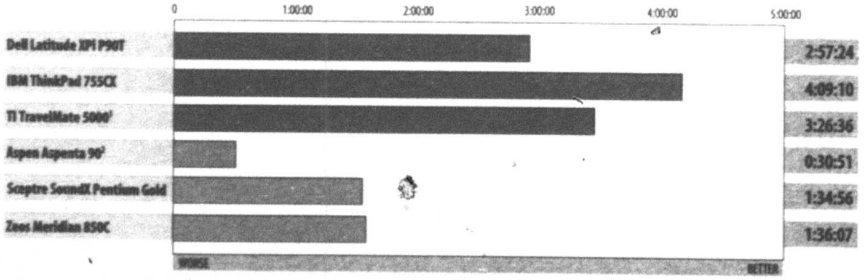
Benchmarks

Live fast, die young

The systems that performed best in our applications suite generally offered the shortest battery life.

Battery life

Times in hours:minutes:seconds — Lithium ion — Nickel-metal-hydride



1. Equipped with standard dual lithium ion batteries.
2. The Aspenta's power-saving settings were incompatible with our battery test. See page 70 for more information.