

Industry researchers predict future of electronic devices

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In ten to 20 years, we will see the e-Sheet, a virtually indestructible e-device that will be as thin and as rollable as a rubber place mat. It will be full color and interactive, while requiring low power to operate since it will charge via sunlight and ambient room light. However, it will be so “tough” and only use wireless connection ports, such that you can leave it out over night in the rain. In fact, you’ll be able to wash it or drop it without damaging the thin, highly flexible casing. Credit: Noel Leon Gauthier, U. of Cincinnati

The just-released February issue of the *Journal of the Society for Information Display* contains the first-ever critical review of current and future prospects for electronic paper functions.

These technologies will bring us devices like:

- full-color, high-speed, low-power e-readers;
- iPads that can be viewed in bright sunlight, or
- e-readers and iPads so flexible that they can be rolled up and put in a pocket.

The University of Cincinnati's Jason Heikenfeld, associate professor of electrical and computer engineering and an internationally recognized researcher in the field of electrofluidics, is the lead author on the paper titled "A Critical Review of the Present and Future Prospects for Electronic Paper." Others contributing to the article are industry researcher Paul Drzaic of Drzaic Consulting Services; research scientist Jong-Souk (John) Yeo of Hewlett-Packard's Imaging and Printing Group; and research scientist Tim Koch, who currently manages Hewlett-Packard's effort to develop flexible electronics.

TOP TEN LIST OF COMING e-DEVICES

Based on this latest article and his ongoing research and development related to [e-paper](#) devices, UC's Heikenfeld provides the following top ten list of [electronic paper](#) devices that consumers can expect both near term and in the next ten to 20 years.

Heikenfeld is part of an internationally prestigious UC team that specializes in research and development of e-devices.



Within ten to 20 years, we will see e-Devices with magazine-quality color, viewable in bright sunlight but requiring low power. “Think of this as the green iPad or e-Reader, combining high function and high color with low power requirements.” said Heikenfeld. Credit: Noel Leon Gauthier, U. of Cincinnati

Coming later this year:

- Color e-readers will be out in the consumer market by mid year in 2011. However, cautions Heikenfeld, the color will be muted as compared to what consumers are accustomed to, say, on an iPad. Researchers will continue to work toward next-generation (brighter) color in e-Readers as well as high-speed functionality that will eventually allow for point-and-click web browsing and video on devices like the Kindle.

Already in use but expansive adoption and breakthroughs imminent:

- Electronic shelf labels in grocery stores. Currently, it takes an employee the whole day to label the shelves in a grocery store. Imagine the cost savings if all such labels could be updated within seconds – allowing for, say, specials for one type of consumer who shops at 10 a.m. and updated specials for other shoppers stopping in at 5:30 p.m. Such electronic shelf labels are already in use in Europe and the West Coast and in limited, experimental use in other locales. The breakthrough for use of such electronic labels came when they could be implemented as low-power devices. Explained Heikenfeld, "The electronic labels basically only consume significant power when they are changed. When it's a set, static message and price, the e-shelf label is consuming such minimal power – thanks to reflective display technology – that it's highly economical and effective." The current e-shelf labels are monochrome, and researchers will keep busy to create high-color labels with low-power needs.
- The new "no knobs" etch-a-sketch. This development allows children to draw with electronic ink and erase the whole screen with the push of a button. It was created based on technology developed in Ohio (Kent State University). Stated Heikenfeld, "Ohio institutions, namely the University of Cincinnati and Kent State, are international leaders in display and liquid optics technology."
- Technology in hot-selling Glow Boards will soon come to signage. Crayola's Glow Board is partially based on UC technology developments, which Crayola then licensed. While the toy allows children to write on a surface that lights up, the technology has many applications, and consumers can expect to see those imminently. These include indoor and outdoor sign displays that when turned off, seem to be clear windows. (Current LCD – liquid crystal display – sign technology requires

extremely high power usage, and when turned off, provide nothing more than a non-transparent black background.)

Coming within two years:

- An e-device that will consume little power while also providing high function and color (video playing and web browsing) while also featuring good visibility in sunlight. Cautions Heikenfeld, "The color on this first-generation low-power, high-function e-device won't be as bright as what you get today from LCD (liquid crystal display) devices (like the iPad) that consume a lot of power. The color on the new low-power, high-function e-device will be about one third as bright as the color you commonly see on printed materials. Researchers, like those of us at UC, will continue to work to produce the Holy Grail of an e-device: bright color, high function (video and web browsing) with low power usage."

Coming within three to five years:

- Color adaptable e-device casings. The color and/or designed pattern of the plastic casing that encloses your cell phone will be adaptable. In other words, you'll be able to change the color of the phone itself to a professional black-and-white for work or to a bright and vivid color pattern for a social outing. "This is highly achievable," said Heikenfeld, adding, "It will be able to change color either automatically by reading the color of your outfit that day or by means of a downloaded app. It's possible because of low-power, reflective technology" (wherein the displayed pattern or color change is powered by available ambient light vs. powered by an electrical charge).

Expect the same feature to become available in devices like appliances. "Yes," said Heikenfeld, "We'll see a color-changing app, so that you can have significant portions of your appliances be one color one day and a different color or pattern the next."

- Bright-color but low-power digital billboards visible both night and day. Currently, the digital billboards commonly seen are based on LEDs (liquid crystal displays), which consume high levels of electric power and still lose color when in direct sunlight. Heikenfeld explained, "We have the technology that would allow these digital billboards to operate by simply reflecting ambient light, just like conventional printed billboards do. That means low power usage and good visibility for the displays even in bright sunlight. However, the color doesn't really sizzle yet, and many advertisers using billboards will not tolerate a washed-out color."
- Foldable or roll-it-up e-devices. Expect that the first-generation foldable e-devices will be monochrome. Color will come later. The first foldable e-devices will come from Polymer Vision in the Netherlands. Color is expected later, using licensed UC-developed technology. The challenge, according to Heikenfeld, in creating foldable e-devices has been the device screen, which is currently made of rigid glass. But what if the screen were a paper-thin plastic that rolled like a window shade? You'd have a device like an iPad that could be folded or rolled up tens of thousands of times. Just roll it up and stick it in your pocket. See a video.

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Provided by University of Cincinnati

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