Display Week 2009 Review: Touch Technology

Touch screens exploded in numbers and capabilities this year.

by Geoff Walker

THIS YEAR was an amazing breakthrough for touch at Display Week 2009. First, there were 27 exhibitors showing touch screens and/or controllers and another 27 showing touch-related products and services. The latter included conductive inks (2), films and coatings (5), glass (3), adhesives (1), integration (3), bonding (6), aftermarket enhancement (3), haptics (1), stylus (1), and market research (2). The total of 54 touch-related exhibitors was more than 25% of the total number of exhibitors at the show! Second, the Symposium included 16 papers directly focused on touch. This is a radical departure from previous years, when the number of papers on touch never exceeded two per year. I'm confident that these characteristics made Display Week 2009 the most touch-oriented conference anywhere in the world.

In another breakthrough statistic, 2009 was the first year that analog resistive was not the most-exhibited touch technology. This year that honor went to projected capacitive, with 11 manufacturers showing product or technology demonstrations versus seven for analog resistive. Finally, one of the unique characteristics of touch at Display Week 2009 was the fact that there was at least one example of 12 of the 13 touch technologies on display (all except vision-based optical such as developed by Microsoft and GestureTek). That made Display Week 2009 an incredible place to be for attendees interested in learning about touch (Table 1).

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Projected Capacitive

The most interesting projected-capacitive (pro-cap hereinafter) demonstrations were from 3M and Gunze. 3M showed a 19-in. LCD multi-touch monitor with a 10-touch ITO-based pro-cap touch screen. The performance of this touch screen was excellent; in fact, it was the best monitor-scale pro-cap touch screen that I have ever seen. Curiously, 3M has not yet decided whether to offer it as a standalone component; the company was offering only the complete monitor as the centerpiece of a $999 "multi-touch development kit."

Table 1: Touch technologies on display at Display Week 2009

Touch Technology	Exhibitors
Projected capacitive	11
Analog resistive	7
LCD in-cell, on-cell, and out-cell	5
Digital resistive	3
Force sensing	2
Conventional infrared	2
Acoustic Pulse Recognition™	1
Dispersive Signal Technology™	1
Optical	1
Surface acoustic wave	1
Surface capacitive	1
Waveguide infrared	1

Gunze demonstrated a new "direct-printing-technology film" in the form of a pro-cap touch sensor. This is very exciting new technology; it offers the possibility of replacing the conventional process of laminating microfine (10-µm) wires between glass and PET with a simple, low-cost printing process. The printed lines on the pro-cap touch sensor were barely visible; to my eye the sensor looked equal to or better than conventional wire-based sensors.

N-trig introduced a battery-powered pen for its dual-mode pro-cap laptop touch screen. Putting the power source in an aftermarket pen allows N-trig to remove the electrostatic pen-energizing coil from the touch screen, transferring some of the cost from the laptop OEM to the end-user. SMK demonstrated a pro-cap touch screen for netbooks that supported 10 simultaneous touches (that's a lot of fingers on a small screen!); Touch International showed a 22-in. product, the largest ITO-based pro-cap touch screen at the show; Tyco Electronics/Elo TouchSystems introduced its new single-layer pro-cap for mobile devices; and Zytronic demonstrated an elegant zero-bezel pro-cap touch screen with capaci-

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tive sensing pads around the edges. Other exhibitors demonstrating pro-cap touch screens included Nissha, Panjit, Wacom, and Wintek.

LCD In-Cell

Display Week 2009 provided the LCD manufacturers with another opportunity to show progress in integrating touch into the structure of an LCD. Unfortunately, in my opinion, little actual progress was demonstrated.

First, some terminology clarification is in order. "In-cell" touch actually exists in three forms, as shown in Table 2. Display Week 2009 included in-cell touch-technology demonstrations from five LCD manufacturers, as shown in Table 3.

Digital Resistive

At Display Week 2008, there was only one sample of digital resistive (shown by Wintek), and it was presented in a very low-key manner. At Display Week 2009, digital resistive had a much higher profile. Stantum, Wintek, and Apex Material Technology (AMT) all showed significant new products in this emerging technology area.

Stantum had a 9-in. digital-resistive touch screen intended for use in netbooks (Fig. 1). The patterning on this touch screen was in 2-mm squares, so the resolution was quite impressive. Handwriting recognition worked reasonably well on this touch screen. Stantum has a single-chip controller due out later this year (essential for design wins in the netbook space), and the company is confident that it can achieve the Windows-7 logo (another essential element of success).

Wintek showed a prototype of a 16-in. wide-aspect digital-resistive touch screen, configured with approximately 20 conductors on the long side (Fig. 2). To my knowledge, this is the largest digital-resistive touch screen that's been shown to date (although there are industry rumors that J-touch in Taiwan has developed a 22-in. commercial product). While digital resistive can theoretically support as many simultaneous touch points as there are X-Y intersections in the sensor, a Wintek booth staff-person said that the 16-in. prototype was limited to three simultaneous touches due to the bandwidth of the controller (assuming 50 Hz per touch point, as specified in the Microsoft logo specification).

Wintek also showed a prototype 4.3-in. digital-resistive touch screen configured as a 64 ×

Table 2: Clarification of LCD in-cell touch terminology

Term	Integration Method
In-cell	The touch sensor is physically inside the LCD cell. The sensor can take the form of micro-switches (contact-closure or so-called "resistive"); capacitive-sensing ITO electrodes (capacitive) or light-sensing phototransistors (optical).
On-cell	The touch sensor is an X-Y array of capacitive-sensing ITO electrodes deposited on the top or bottom surface of the color-filter substrate (this method is capacitive only).
Out-cell	This new term, recently coined by AUO, describes the configuration in which a standard touch screen (typically only resistive or projected-capacitive) is laminated directly on top of the LCD during manufacture. The key difference is that this configuration requires an additional piece of glass. Since this term hasn't entered common usage yet, some LCD manufacturers still refer to this configuration as on-cell.

Table 3: LCD in-cell, on-cell, and out-cell touch demonstrated at Display Week 2009

Manufacturer	Type	Author's Comments
Ampire & Hannstar	In-cell optical	Ampire, a controller manufacturer, partnered with Hannstar to develop a prototype of in-cell optical installed in a netbook. However, to simplify the difficult problem of sensing in-cell optical touch from total darkness to full sunlight, the company designed the prototype to work only with a laser-pointer light pen.
LG Display	In-cell and out-cell capacitive	LG's in-cell capacitive performed very poorly. There was a very large amount of cursor lag; movement of more than a few inches per second resulted in the ink devolving into random segments; and there was at least a half-finger's worth of cursor jitter. LG's out-cell capacitive performed acceptably with no unusual characteristics.
NEC	In-cell capacitive	NEC's in-cell capacitive was only on display for the first half-day of the show due to demo hardware failure, so I was unable to view it.
Samsung	On-cell capacitive and out-cell resistive	Samsung's on-cell capacitive worked acceptably, but it showed unusually severe pooling. Samsung's out-cell digital resistive was used to demonstrate a gesture recognizer that allowed up to three touches, but the recognition seemed to be grossly unreliable.
TMD	Out-cell capacitive and resistive	Although TMD has previously shown in-cell optical, at Display Week 2009 a booth staff-person stated that TMD's in-cell and on-cell capacitive and resistive were still under development and not ready to be shown yet. TMD's out-cell capacitive had no unusual characteristics, but its out-cell resistive had an exceptionally light activation force, almost as light as capacitive!

Fig. 1: *This on-screen keyboard used a digital-resistive touch screen from Stantum. The booth staff-person was able to touch type on this screen even without tactile feedback.*

36 matrix. This very high-resolution device was developed jointly with Stantum.

AMT demonstrated a new 20-segment digital-resistive touch screen. While Stantum's and Wintek's designs are intended to compete directly with pro-cap in applications such as netbooks that require "all points addressable" (APA) functionality, AMT's new product is aimed at vertical-market applications in which the number and location of simultaneous touches are applications-specific.

Other Touch Technologies

Although pro-cap, LCD in-cell, and digital-resistive technologies accounted for more than half of the touch screens shown at Display Week 2009, there were some interesting nuggets to be found in several of the other touch technologies, as follows.

- NextWindow demonstrated its latest optical touch screens in both desktop and large-format (> 30-in.) sizes. The desktop demonstrations were in the form of components used by HP and Dell in their TouchSmart and Studio One all-in-one consumer PCs (respectively). Optical is the first touch technology to penetrate the consumer desktop space in high volume, and NextWindow is the first optical-touch-screen manufacturer to have achieved the Windows-7 logo. NextWindow has shipped more than a half-million touch screens into the consumer PC market thus far.
- Tyco Electronics/Elo TouchSystems demonstrated the first multi-touch surface-acoustic-wave (SAW) touch screen. The move to multi-touch was accomplished by adding a second set of reflectors around the edge of the screen. This second set reflects the surface acoustic waves across the diagonal of the screen; the controller uses the X, Y, and "U" (Elo's designation for the diagonal direction) waves to unambiguously triangulate the location of two touches. Elo also demonstrated a very elegant zero-bezel Acoustic Pulse Recognition (APR) touch screen with capacitive touch pads and a scroll-dial along one edge. All the circuitry for the touch pads and scroll dial was on the back of the glass; the on-glass circuit capability was provided by Felam Glasline in Germany.

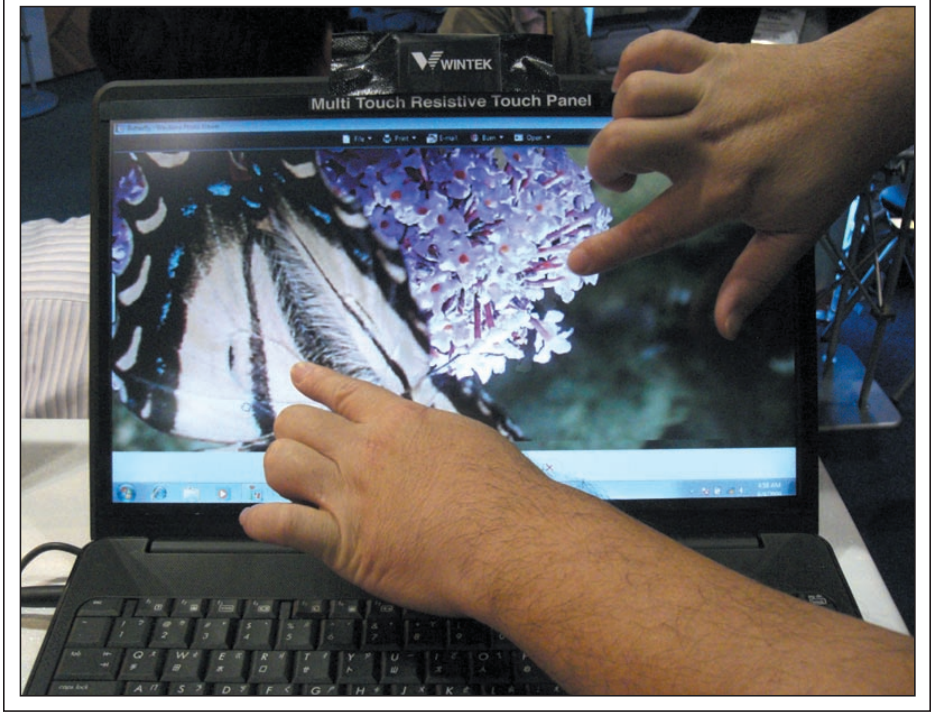

Fig. 2: *This prototype of a 16-in. wide-aspect digital-resistive multi-touch touch screen from Wintek is installed in a laptop. This is probably the largest digital-resistive touch screen that has been shown to date.*

- Fujitsu demonstrated an improved 5-wire analog-resistive controller that was developed in response to customer requests for faster response. It certainly is fast – I was able to draw circles at 60 in./sec (as fast as my arm and hand could move!) without any loss of data points.
- Nissha showed a prototype of a force-sensor added to an analog-resistive mobile-phone touch screen, presumably in an attempt to mimic the BlackBerry Storm's "Click-Through" technology. The performance was uneven, however, with the result that significantly different levels of force were required at different screen locations. Nissha agreed that the implementation was not ready for production yet.
- RPO, which has changed its focus from the mobile-phone space to the netbook and laptop space, showed a 7-in. waveguide infrared touch screen intended for netbooks. The maximum border width was about 6 mm and the maximum bezel height was slightly over 1 mm. The touch screen used only three IR LEDs, two on the long side and one on the short side (this results in very low power consumption, one of the key advantages of waveguide infrared).
- Vissumo (a spin-out from QSI Corp.) demonstrated its force-sensing touch technology (Fig. 3). Several of the hardware models in its booth showed very clearly one of the technology's unique advantages – the ability to create a 3-D touch surface that can incorporate any rigid material (stone, glass, steel, plastic, ceramic, *etc*.) as well as LCDs, speakers, snap-domes, electric motors, and other hardware. No other touch technology can do this.

Fig. 3: *This display features a mockup of a gas pump using Vissumo's force-sensing touch screen. Rugged outdoor touch applications such as this take advantage of force-sensing's high degree of resistance to adverse environmental conditions.*

Summary

There was so much touch technology on the floor at Display Week 2009 that it could not all be seen in one day. Projected capacitive leaped to the forefront of the touch technologies on display, surpassing analog resistive for the first time. LCD in-cell made a rather poor showing, with little visible progress over the last year. Digital resistive emerged as a lower-cost alternative to projected capacitive. Interesting examples of all the other touch technologies were present. It was one heck of a show! ■