QUARTERLY OF THE INDUSTRIAL DESIGNERS SOCIETY OF AMERICA **SUMMER 2010**

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Interactive Experiences

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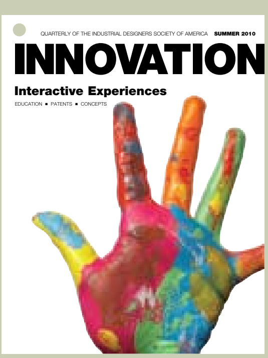

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Modern Interface Design

INTIMATE INTERACTION

For the past several decades, research laboratories across the world have developed dramatic new ways of interaction using gestures and body movement. Most of these developments were discussed only at academic research conferences; although sometimes they are visible in science-fiction movies. *Minority Report* is one of the more spectacular demonstrations with its gestural interfaces and interactive shop advertisements that recognize people in the halls and pitch customized ads to them. These advances need not be relegated to science fiction: gestural controls and inexpensive smart sensors are here. Just look at the Nintendo Wii or the progress in cell phone interfaces.

Progress in product functionality has demanded improved user interfaces in cell phones and introduced us to new touchscreen technologies.

Knobs and dials, switches and levers, labels and low quality displays: that's the old way of designing controls and displays. The control of devices, usually called the human-machine interface (HMI), is about to undergo rapid change providing designers with great opportunities—whether it is tractors or oil-well controls, automobiles or wall ovens, industrial mixers or drink machines, MRI scanners or infusion pumps. Novel HMIs will enhance performance, reduce errors, and lower maintenance and training costs.

For the average consumer, the change was first apparent with smart touch-sensitive cell phones and other consumer electronic products. But now the change is moving to durable goods, a category that includes home appliances, commercial restaurant and medical equipment, manufacturing tools, and all commercial and military machines. **In the past, the controls and displays on durable goods were thought of as necessary distractions, often interfering with the clean lines and function of the design. Today, they can be the centerpiece: attractive, colorful and defining.** And they can provide dynamic movement to otherwise fixed mechanical structures.

New touch-sensitive screens bring the costs of these systems to levels that can be cost competitive with mechanical switches. The action-oriented interaction we associate with modern smart phones and video games is now robust, reliable and inexpensive enough to change the world of industry and commerce. We can control product operation with a fingertip touch or flick gesture, or a two-point touch gesture such as a pinch and zoom with the thumb and index finger. These new approaches to the user interface can make jobs easier to do, reduce training time and reduce errors. At the same time, it makes jobs more enjoyable, increases productivity, lowers costs and decreases maintenance costs.

Sound too good to be true? Well, that's what technology breakthroughs are about. In this case, the technology breakthrough is not about the innovation itself—the technologies have been around for decades. The breakthrough is what the technologies can now offer:

- Durable and robust mechanical constructions with progressive aesthetics
- High reliability, even in extreme environmental conditions
- The ability to include various display types, including large color screens, allowing graphical and textual controls that reduce confusion and that can be self-instructing
- The ease of tailored specification for the job.
- The ability to change the interface controls and displays rapidly and inexpensively without any other modification
- Affordability and cost effectiveness versus traditional HMI technologies

A special benefit of these new technologies is their ease of customization, tailored specifically for the needs of the manufacturer. One basic design platform can be readily adapted to particular needs. For instance, a restaurant can change the display daily—hourly, if need be—to match its menu changes. A central office can modify all the displays used across the world either by downloading a new structure over a secure encrypted Internet connection or by dispatching new memory cards that can be inserted into the devices. Any given location can rapidly decide which configuration best fits its needs. The changes can include new controls, new action items, new point-of-sale graphics, weekly or daily specials, or instructional videos. The language of the display can even be changed for each user. The potential is enormous.

Consumer appliances (white goods) are closely related to the world of consumer electronics, so we would expect these arenas to be the first to start moving into these new styles of interaction. Surprisingly, the first steps occurred elsewhere, such as the Coca-Cola Company's Freestyle unit that allows customers to customize their own drinks. Just select the desired ingredients from the choices offered on the touchscreen display and a custom drink is delivered.

Ready for Change

Groundbreaking interaction design seldom happens in the world of durable goods. It's not glorious—no industrial equipment star designers are highlighted in magazines, no salon shows are dedicated to commercial equipment. Innovative client/customer patrons may be hard to find. Equipment for the test and measurement industry and medicine has also tended to follow the tradition of slow rates of change. For instance, category-changing oscilloscopes have incorporated modern computer operating systems, but still use old-fashioned controls.

With medical equipment, functionality usually dominates. However, our experience with an increasing rate of medical error indicates that we need to pay more attention to the user experience including better and more human-centered displays and controls. Medical personnel face frequent interruptions, so the controls must be designed with this in mind. If a device can't deliver drugs effectively, the patient suffers, sometimes in a way no one ever intends. For instance, infusion pumps are notoriously difficult for the medical staff, resulting in frequent errors and much frustration.

The same problems appear in much of the sophisticated equipment used in today's hospitals. **Human error is invariably a design error, often caused by ambiguous, restricted design of the controls or displays.** With modern transparent touch-sensitive displays over a color LCD display, the controls can be easier to understand, self-instructing, error correcting, and better able to display the

Developers of Coca-Cola's Freestyle drink dispenser combined state-of-the-art mechanics with a new touchscreen-based human-machine interface.

state of the device and its operation for the physicians and nurses who must monitor the patient. Moreover, it is possible to put these displays and controls in fully sealed enclosures making the device easier to sanitize and keep clean.

For a chain of commercial restaurants, UICO was asked to redesign the controls of a drink dispenser, replacing the existing traditional membrane switch panel that had multiple poorly differentiated buttons for drink dispensing and maintenance tasks. We replaced it with a projected capacitive touchscreen that guides operators through use via a "what you need when you need it" HMI approach. That is, the panel provides several high-level choices, and whenever one is selected, the display and controls change to be appropriate to the selected activity. For maintenance, the screen serves as a simple tutorial, instructing the workers just how to perform each step and only moving on to the next screen when the current step has been completed.

The system was encased in a watertight enclosure that held a single board computer. The result was unheralded ease of use by semi-skilled labor in a fast-food setting. The sound and supportive self-instructing graphics clarified the maintenance tasks. Moreover, the language being displayed is easily changed to accommodate each worker. The result? Drink quality and throughput has been markedly improved.

A Gamut of Touchscreen Technologies

So how do we make great user experiences for folks wanting to cook a turkey, dispense medicines or effectively control factory machines? For the moment, we'll call the most promising frontier of usability "intimate interaction." It is achieved by combining relevant presentation layers with engaging input modes.

This trend is being clearly marked by the ubiquitous shift from basic interfacing using keypads or a mouse to the engaging touchscreen consisting of a high-resolution display with a sophisticated human-machine interface. The result is a new standard of engagement for how a product may be used.

Touchscreen Technology Comparison

Technology	Capacitive Systems: Projected — Capacitive electric field thru material(s)	Capacitive Systems: Surface — Capacitive electric field on material surface	SAW — Surface acoustic waves	Infrared — Light interruption	Resistive: 4/5/8 wire — Mechanical
Input Method	◉ Finger, gloved finger, conductive stylus.	○ Finger, conductive stylus.	◉ Finger, gloved finger or soft tip stylus.	◉ Finger, gloved finger or stylus pen.	◉ Finger, gloved finger or stylus pen.
Activation	◉ Activation sensitivity can be customizable. Activation pressure is consistent across substrate.	◓ Activation sensitivity is non-customizable. Activation pressure is consistent across substrate.	◓ Activation sensitivity is non-customizable. Activation pressure is consistent across substrate.	● High degree of false actuation due to zero pressure.	◒ Activation sensitivity is non-customizable. Activation pressure is inconsistent across substrate & over time.
Surface Hardness	◉ High. More than 9H.	◓ Medium. Varies on any protective coating.	◉ High. More than 9H.	◉ High. More than 9H.	● Low. Only 3H.
Durability/ Longevity	◉ High. Solid-state technology protected thru thin or thick rigid substrates; highly shock/impact resistant.	○ Medium. Solid-state design through thin rigid substrates; medium level of shock and impact resistance.	● Low. Highly susceptible to stress or wear in mechanical construction over time.	● Low. Highly susceptible to stress or wear in mechanical construction over time.	● Low. Easily damaged by foreign objects &/or harsh cleaners. Highly subject to wear under heavy use.
Surface or Environmental Contaminants	◉ Best units immune to water, moisture and other contaminants or chemical cleaners; wide temperature range.	◒ Does not work when wet or moist.	● Adversely affected by moisture, surface contaminants and changes in temperature.	● Potential for false actuation or dead zones from surface contaminants.	◒ Typical construction easily scratched and degrades with UV exposure; varying performance at different temps.
Use with Gloves	◉ Yes (depending on type of system)	○ No	◉ Yes	◉ Yes	◉ Yes
Sensor Substrate Types	◉ Thicker glass . some plastics possible with choices depending on use & interactions.	◓ Typically soda lime glass.	○ Glass only.	◉ Any substrate.	● Typical polyester film or other plastic type construction is actual switch.
Gestures (Single Touch to Drag & Drop, Pinch/Zoom)	◉ Yes	○ Limited	○ Yes	● Low resolution due to spacing & interpolation.	◒ Single touch; requires constant pressure.
Multitouch	◉ Yes	● No	● No	● No	● No
Calibration	◉ None required.	● Yes, required periodically.	● Yes, required periodically.	◉ None required.	● Yes, required periodically.
Surface Shape	○ Flat or curved one direction only.	● Flat only.	● Flat only.	● Flat only.	● Flat only.
Transmissivity Optics	◓ Very good >92%	◓ Very good >92%	◓ Very good >92%	◉ No distortion 100%	◒ Distortion due to coatings <82%

◉ ◓ ○ ◒ ●
better < > worse

These control panel assemblies for street sweepers were designed 20 years apart using off-the-shelf rocker switches. Today, color LCD displays with touch-sensitive interfaces could replace many of the required controls and dramatically enhance product ease of use.

There are significant differences among touchscreen systems. By far the most engaging and capable touchscreen technology is projected capacitive, which allows the type of intimate interaction now familiar to consumers because of its use in smart phones. With an advanced sensing circuit controlled through sophisticated software running on a PCB-mounted microcontroller chip, a projective capacitive touchscreen can support full gesturing and multitouch, making it both highly functional and extremely engaging to a user.

Surprisingly, projected capacitive is not only the most engaging technology but can also be made highly robust as the sensing circuit and controller are typically mounted and protected behind durable substrates of decorated tempered glass and engineering-grade plastics. At least one company now offers projective capacitive touchscreens that work through gloves and when wet with water, opening up new opportunities for products to be both durable and highly innovative.

Resistive touchscreens have two conductive layers that form a conductive path when the finger or stylus applies pressure to a spot. These technologies are inexpensive. Moreover, they are capable of sensing the amount of pressure, making it possible to do different actions depending upon how hard a person is pushing. However, their thin films distort optical clarity, often have inconsistent sensitivity, wear out quickly, and do not support the type of intimate, fun interactions that a projective capacitive touchscreen does.

Some other lesser-known technologies include surface acoustic wave, infrared and surface capacitive. Each of these has advantages over a resistive system, but none has the combination of functionality, reliability and durability of projective capacitive. In certain circumstances, however, they make sense, especially when larger displays are desired or the higher-end functionality offered by the projected capacitive systems are not required.

Projected capacitive touchscreens often offer the best combination of functionality, reliability and durability. When implemented effectively, they make products sing and users take notice. The key is to design from the inside out—that is, architect the interaction and then choose and implement a technology that is supportive. And, as with the implementation of any innovative technology, find a partner who knows how to make this stuff really work and who you can work with and trust.

Thrilling Users

The new display and control technologies promise huge opportunities for the design profession. We are now free of the tyranny of fixed mechanical controls, which are ugly to look at, fixed in space and time, and unreliable. **The new systems can be molded into a pleasurable experience for the eye and hand, offer increased flexibility for designers, and are dramatically easier for people to use because of their colorful images and room for explanatory text.** At the same time, they can be less expensive and more reliable than the previous generation of mechanical and membrane switches.

The result will be great design for both consumers and durable goods with increased capabilities, ease of use and reliability. Customers and companies will seek products with richer experiences, and there will be a need for appropriate user interfaces and HMI sub-assemblies that represent the change to the new standard of intimate interaction.

For better product and user-interface designs seeking a touch system, projected capacitive technology is today's flag bearer, in addition to a number of other emerging ways to interact with and manipulate products. As with any good design program, technology should be used as appropriate to deliver the desired end result. Keep in mind all users and stakeholders, strive for simplicity in any GUI undertaking, and seek durable and robust human-machine interface constructions such that users are thrilled. ■

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