In the Create a Chemical Reaction exhibit, visitors can mix elements from the periodic table to create salt or (safely) blow things up. Photo courtesy the Museum of Science and Industry

Human Computer Interaction and the Next Generation of Science Center Exhibits

By Jim Spadaccini

Computer-based technology continues to evolve at an ever-accelerating rate, creating both opportunities and challenges for science centers and museums. We are now seeing computing enter new realms, ones that are potentially more promising for exhibit development than earlier ones.

Human computer interaction (HCI) is a term that describes a whole new array of technologies including, but not limited to, touch and touchless gestural interaction, augmented reality (computer-generated imagery superimposed on a visitor's view of the real world), voice recognition, wearable technology (clothing and accessories that incorporate electronic technology), and smart objects (objects that have embedded technology and can interact with other technology or a network). (See the sidebar on page 46.) These new technologies, which leave the keyboard and mouse behind, are by their nature more physical, more social, more intuitive, and much better suited for exhibit development than their predecessors.

THE ARGUMENT FOR HIGH-TECH EXHIBITS

It is important to acknowledge that a fair number of people in the field

still believe that computers simply don't belong in science centers. They argue that computers provide "virtual" experiences, not real ones, and that they are information heavy, have limited interactivity, are nonphysical, and tend to create experiences for individuals, rather than groups. Furthermore, they contend that many of these exhibits are essentially presented as "black boxes" that visitors cannot easily understand. These arguments hold some truth, particularly when looking at the kiosks, audio tours, and other technological implementations that have dominated technology-based exhibit development over the last couple of decades.

However, I believe that new technologies are vastly different from their predecessors and can be used to create compelling visitor experiences.

First, our daily lives involve all sorts of new technologies, so employing these very technologies in science center exhibits reflects what our visitors encounter in society. If part of the mission of science centers is to help us explain the world we experience, one could make the argument that a low-tech science center would become less and less relevant to daily life as technology continues to advance at a relentless pace.

Second, what about understanding science and how scientists conduct their work? Virtually every scientific endeavor takes advantage of new advances in technology—computer imaging, simulation programs, remote data collection, and other innovations. As the public learns more about high-tech approaches to science, it is logical to assume that visitors will expect science centers to use some of the same tools to create high-tech exhibits and experiences.

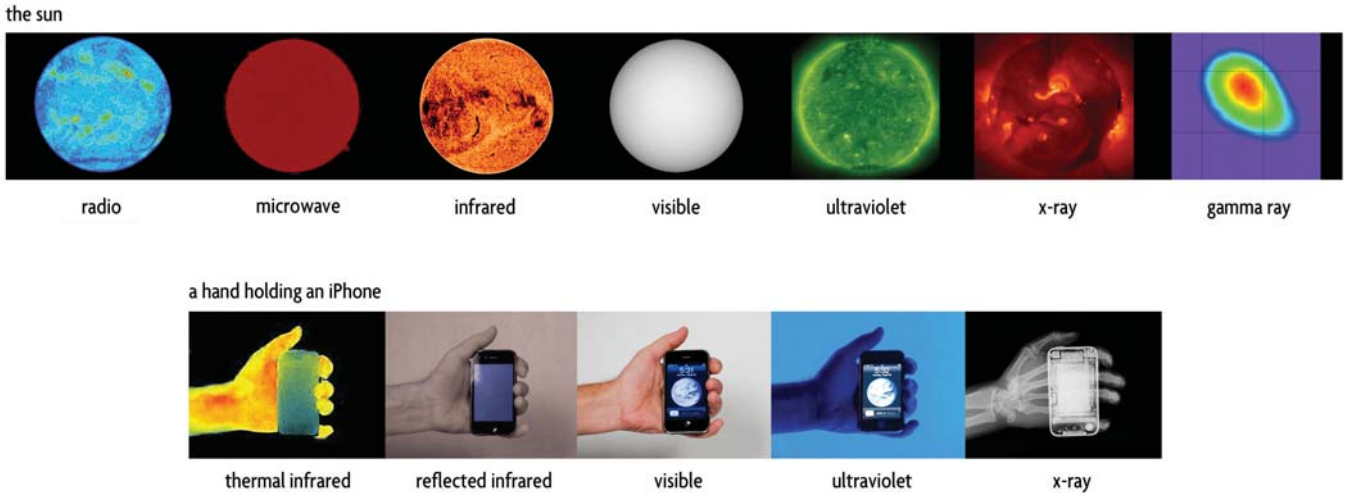
If we believe that science centers need to be relevant to people's everyday lives and help explain current science while inspiring the next generation of scientists, then we simply have to employ technology in science centers. The real question is *how* science centers should use computer-based technologies.

BEST PRACTICES FOR EXHIBITS USING HCI

HCI broadly encompasses a whole variety of approaches that don't include a keyboard or mouse. This is welcome news in exhibit spaces where a keyboard and mouse have always seemed out of place; they fit better in a home, work, or school setting. Here, I describe three best practices for designing exhibits that use new HCI technology to tackle fundamental scientific concepts and topics that would be difficult to address effectively using other means.

1. Allow multiple users to interact with each other and with real scientific data.

My company, Ideum in Corrales, New Mexico, developed with the Adventure Science Center, Nashville, Tennessee, and later for the Museum of Science and Industry, Chicago, a multitouch table to explore the electromagnetic spectrum. Multitouch tables and large touch walls have become a fairly standard exhibit element over the last few



Visitors can move images of celestial and terrestrial objects (above) across a multitouch table (opposite) developed by Ideum and the Adventure Science Center to see how the objects appear in different wavelengths. Images courtesy Ideum

years. This exhibit is presented on a particularly large multitouch table, 100 inches (254 cm) long, which allows up to eight visitors to interact simultaneously. The exhibit contains 25 images of celestial and terrestrial objects. As visitors move these images across the length of the table, the images change, showing how the objects appear in various wavelengths. Contextual descriptions of each image, in each wavelength, provide deeper descriptions of what visitors are seeing. Visitors can also "walk" their images across the length of the table, providing a quasi-physical experience. The images that appear on the table are real scientific data imaged with high-tech hardware; there is nothing "virtual" here.

2. Explore concepts that are difficult to examine in other ways.

Developed by Patten Studios with Chicago's Museum of Science and Industry, the exhibit Create a Chemical Reaction allows visitors to select elements from the periodic table and mix them. Visitors move pucks embedded with radio frequency identification (RFID) chips across the exhibit's surface to make their selections. These tangible pucks help make the experience more engaging and memorable.

This decidedly "virtual" exhibit allows visitors to explore fundamental concepts about the periodic table and chemical reactions. While a chemistry set or museum lab experience might be preferable, this simulated version has the advantage of working safely and quickly with thousands of casual visitors to the museum.

3. Present complex scientific ideas cohesively.

Atmosphere, developed by the Science Museum in London, is an ambitious exhibition exploring climate change. It blends a variety of high-tech HCI exhibits; objects (including ice cores, tree rings, radiometers, and weather balloons); colorful projection; and other exhibit-design elements to create an immersive environment.

The environment itself provides a great deal of cohesion and creates a space in which one wants to linger. The exhibits employ various new technologies (some more effectively than others), and collectively they explore different aspects of climate change, climate research, and atmospheric science. Hands-on, touch, motion-recognition, and animated multiuser games and simulations help explain the complex scientific concepts and the potential consequences of global climate change in engaging ways.

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USING TECHNOLOGY WISELY

The use of computer-based technology has always been heavily scrutinized in

the museum world, and I think some of that has been warranted. The pace of change, the cost, and frankly, the mixed results of computer-based exhibits in the past have contributed to this scrutiny. However, the pace of change means that many of the lessons we have learned about technology and technological approaches to exhibit development need to be revisited.

The types of interaction and the quality and fidelity of HCI technology are accelerating. Therefore, experiences that were not possible just a few years ago can now be easily implemented.

In some cases, as I've demonstrated, HCI technology is already being used to explore complex scientific concepts in effective ways. In addition, the high-tech tool kit that exhibit developers have at their disposal is continually evolving and, importantly, the most effective practices in this type of exhibit development are also improving. High-tech exhibits have earned a place at the table, and whether high tech or low tech, the goal is the same: to create meaningful exhibits that inspire our visitors and spark a greater interest in science. ■

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WHAT'S NEXT IN HIGH TECH?

Touchless

Touchless motion recognition became a mainstream technology in 2011 with the release of Microsoft Kinect software. Early on, various exhibit developers explored Kinect and used it in a few installations. Most Kinect-based exhibits require a single user and full body motion, which are major limitations, but by all indications, this will change dramatically over the next few years. New devices with higher fidelity, including "time-of-flight" devices that use pulses of infrared light to more accurately detect motion, will allow for exhibits that can accommodate multiple users and track movements down to that of individual fingers.

Augmented Reality, Wearables, and Ambient Interfaces

Many augmented reality (AR) applications built to date require a mobile device, making them impractical for most hands-on exhibits in science centers, where visitors need to keep their hands free. However, wearable devices like Google Glass, as well as projection and transparent liquid-crystal displays (LCDs), open up possibilities for interpretive materials and augmented views of museum objects and scientific phenomena. The key is making these layers unobtrusive to allow visitors to interact and access additional information when and where they want it. The Augmented Reality for Interpretive and Experiential Learning (ARIEL) project of the Franklin Institute, Philadelphia, and a few others have been using AR with separate screens displaying additional information *(www.fi.edu/ariel).*

More and Smart(er) Objects

Object recognition, radio frequency identification (RFID), and other technologies are allowing physical objects to communicate with computers, the internet, and each other. Imagine being able to retrieve information from an item in a museum as you hold it, or to view information not normally seen when interacting with phenomena (e.g., physical forces, temperature, magnetic fields, etc.) As these technologies continue to evolve, we will see new exhibit applications using them. Low-tech exhibit developers with a deep understanding of the physical and social interactions that we see around objects and phenomena could contribute a great deal to the development of smart object interactions.

—J.S.