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1. INTRODUCTION

The National Weather Service (NWS) Weather Forecast Office (WFO) in Lubbock, Texas is co-located with the Science Spectrum, a popular non-profit museum for science education. The Science Spectrum hosts over 150,000 persons annually at the museum facility. Teachers, students, families and individual visitors come to the museum from a large region of West Texas and eastern New Mexico for hands-on science activities, film (Omni Theater), live presentations and exhibitions. This arrangement presented an excellent opportunity for the WFO Lubbock office to promote the science of weather in a museum environment, and thereby increasing the visibility of the NWS.

In 2004, WFO Lubbock formed a local team to design and construct a professional-looking, interactive weather information display. The goal was to both educate and entertain children and adults alike, with an emphasis on severe weather preparedness information. Through close partnership with Science Spectrum management, the display was given a prominent location within the museum. The team designed, constructed and deployed the display during the winter, spring and summer of 2004.

This paper will summarize the construction and development, educational features, and future expansion plans of the display.

2. COMPONENTS OVERVIEW

The centerpiece of the display is a large-screen LCD monitor that continuously displays a short presentation highlighting a variety of weather topics and information about the NWS mission. To the left of the LCD monitor is a touch-screen monitor that provides more detailed information on weather safety, a look at the history of the NWS and at the operations of WFO Lubbock, and features the popular "Jetstream" educational site from the NWS Southern Region web site. To the right is another monitor where visitors can browse live weather information on the Internet through a series of custom-designed websites that organize the information by topic. Another section educates visitors about NOAA Weather Radio All Hazards (NWR), shows a map of the WFO Lubbock transmitter coverage areas, and provides live audio of radio broadcasts directly from the Lubbock WFO.

Another interactive part of the display is an exercise bicycle modified with a generator connected to a motorized fan. By pedaling the bicycle, visitors can "operate" an anemometer and wind vane attached to a short instrument tower. The entire display (with the exception of the bicycle and NWR display) is housed in a hand-made varnished wood cabinet for a rustic, "Texas-style" motif. The display is located on the second floor of the Science Spectrum within a 200 foot-square area roughly in the middle of the exhibit floor. Figure 1 shows a photograph of the completed display in the Science Spectrum.

3. LCD MONITOR

The centerpiece of the display is a 50 inch-wide LCD monitor that displays a continuously cycling short presentation highlighting a variety of weather topics and information about the NWS mission. The presentation includes loops of satellite and radar images that show examples of weather phenomena and introduces some NWS forecasting techniques (such as the detection of a cold air mass using an infrared satellite loop). Severe or extreme weather is emphasized to help draw attention to the display. Examples include local events such as the tornado that hit Happy, Texas on 5 May, 2002 and well-known national events such as Hurricane Katrina. Additional slides explore topics such as lightning, flash floods and weather safety. Figure 2 shows a photograph of the LCD monitor.

4. TOUCH SCREEN

While the LCD monitor conveys a lot of information, it is not interactive. The designers of the display desired to create as much of a hands-on and personalized experience as possible; essential to maintain children's interest. The touch screen computer/monitor system allows the user to select from a wide variety of topics, ranging from frivolous (weather jokes) to an in-depth discussion of the F-scale (soon to be updated). In addition, the touch screen display allows users to access a local copy of the "Jetstream" educational website (<http://www.srh.weather.gov/srh/jetstream/>). Another popular feature is the "Weather Quiz", where users can test their knowledge of weather through a "easy" and "hard" quiz. All the information for the touch screen display was organized like a website, with individual pages created in hypertext markup language (html) and linked together with easy navigation buttons. The weather quiz utilizes a JavaScript program. A close-up of the touch screen display is shown in Figure 3.

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5. INTERACTIVE WEB BROWSER

This component allows the user to explore real-time weather information and also access a large variety of weather-related websites using a live internet connection. The internet connection is provided by a digital cable internet service provider to the adjoining NWS office. A LAN cable was run from the NWS office along the ceiling of the science spectrum, and then lowered into the display (conduit is visible at the top of Figure 1). Similar to the touch-screen display, several web pages were developed and stored locally on the PC to provide several starting points to aid the user in data exploration. There is no keyboard, and no address bar in the internet browser, so the user is limited to clicking on visible links using a rugged, industrial touchpad in lieu of a mouse. With only a few exceptions, the user is also limited to browsing .edu and .gov domains by the utilization of Microsoft Windows security settings. The home page has links to six primary pages: The local NWS Lubbock Homepage, Radar page, Satellite page, Surface maps and data page, Storms page, and Other Cool links page. Each of the six main pages contains dozen of links to websites from educational and governmental institutions around the world. Figure 4 shows the web browser display.

6. INSTRUMENTED TOWER

The instrumented tower is a unique exhibit whereby the operator pedals a bicycle which powers a dc fan connected to the ceiling. Adjacent to the bicycle is a seven-foot tall section of an actual instrument tower. The fan blows air onto the top of the tower where a three-cup and vane anemometer is located. The airflow produced by the fan is proportional to the speed in which the operator pedals. The anemometer and the wind speed and direction indicators are all surplus equipment taken from a decommissioned F-420C system. The wind speed indicator displays the wind speed in knots. Since these units of speed are not in widespread use, especially among children, the opportunity is taken to expose the user to concepts of unit conversions through additional signage located under the gages. Even the Beaufort scale is introduced, since it uses descriptive language to explain the effects of wind speed. It is probably the most popular segment of the display since children enjoy seeing how fast they can make the wind blow using the apparatus. To the right of the bicycle is some signage that shows a schematic of a NWS Automated Surface Observing System (ASOS) and explains all the different components. Figure 5 shows the instrument tower and bicycle display.

7. NOAA WEATHER RADIO DISPLAY

This display allows the user to listen to live NOAA weather radio broadcasts originating from the NWS Lubbock office. Since special receivers are required to pick up the broadcast, for many visitors this will be their first exposure to this important federal service. The main

purpose of the NOAA broadcast is to directly warn the public of impending hazardous conditions. However, it also provides continuous routine weather observations, forecasts, and other useful information produced by the local NWS office. The display is housed in a refurbished Automation of Field Operations and Services (AFOS) cabinet housing. A regional map shows the position of each transmitter and a color overlay shows the approximate area around each receiver where the signal can be received. There is a button for each of the three transmitters operated by the Lubbock office (at least one more transmitter will be added in 2007). The audio is only activated when the user is holding down the button for a single transmitter. A light on the map is also turned on at the transmitter's location when the button is pressed. The NOAA weather radio display is shown in Figure 6.

8. ADDITIONAL COMPONENTS AND OPERATION

On the left side of the LCD monitor signage provides a short history of the NWS Lubbock office and the Co-operative observer program. Signage on the right side shows the geographical region that the Lubbock office serves, and gives a brief introduction to some of the most important and popular products and forecasts that the office produces.

The display as a whole requires little in the way of day-to-day maintenance. Access to the computer and equipment compartments is provided through several locked panels located in the back of the display. Figure 7 shows the back of the display and several access points. Forecasters are asked to check on the display twice daily to insure it is functioning properly. The PCs occasionally have to be rebooted if there has been a temporary outage of power or internet service. The main LCD monitor is turned off when the Science Spectrum is closed to prolong its lifespan. Several minor repairs have been made to the bicycle as it is the component that receives the most wear and tear.

9. FUTURE PLANS AND EXPANSION

In order to keep the exhibit engaging and maintain interest with repeat visitors, presentation material should be periodically updated with timely and popular weather subjects. An example might be the addition of an introduction to the ENSO cycle and links to current information. The weather jokes and weather quiz section of the touch screen display are two components particularly sensitive to growing stale for repeat visitors and will benefit from revision. In addition, the nature of the internet requires that website links be frequently checked and updated as necessary. The NOAA weather radio display will be also updated as new transmitters are established.

We would like to add additional interactive components to the display. Discussions have included a tornado simulator, a weather map production studio, and a virtual instrument lab where users can experiment with the equation of state.



FIG. 1. Front view showing all the components of the display. The display is currently located near the middle of exhibit space on the 2nd floor of the Science Spectrum .



FIG. 2. Close-up of the LCD monitor. The screen is protected by a sheet of acrylic glass installed in front of the monitor. The presentation is produced and displayed using Microsoft PowerPoint in kiosk mode.



FIG. 3. The touch screen display. The screen is a 17" LCD monitor manufactured by Tyco Electronics Corporation (<http://www.elotouch.com/>). This model came with USB drivers for operability with a PC running Microsoft Windows.



FIG. 4. The web browser display. The photograph shows the home page where the user selects from six options to begin their browsing experience. The mouse is manufactured by Interlink Electronics Corp. (<http://www.interlinksensors.com/>) and is designed for a harsh, high-use environment.



FIG. 5. The instrumented tower and bicycle display. The fan is barely visible in the upper-left corner. Another fan blows air out of the top of the main enclosure to gently rotate the wind vane.



FIG. 6. The NOAA Weather Radio display. When a button is depressed, the program audio is played, and the appropriate transmitter lights up on the map.



FIG. 7. The back of the display showing the various compartment access panels. The open panel shows the location of the web browser and the presentation PCs.