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REVIVING THE SYNOPTIC LAB WITH UNIQUE DIGITAL DISPLAY SYSTEMS

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1. BACKGROUND

It is widely recognized that a synoptic laboratory is a vital part of any meteorology education. A well-maintained synoptic laboratory is as important to an Atmospheric Sciences program as a Physics or Chemistry laboratory is to those programs. Access to both real-time and archived datasets of weather phenomena is crucial to a student's understanding of atmospheric processes. A continuing challenge for students is recognizing and applying the lessons of atmospheric dynamics/physics in the study of actual weather systems.

Most importantly, the synoptic laboratory is the place where much of the interaction between students, faculty, and staff normally occurs. It is a meeting place to which faculty and students often migrate whenever an interesting weather event is unfolding. Ideally, it should be a venue for stimulating discussions and for fostering effective interaction between students, staff and faculty.

At one time, a synoptic laboratory in a university meteorology program was the most frequented location in the building...it was the only place one could obtain the latest weather data and was frequently the site of highly beneficial interaction and discussion between students and faculty.

At the University of Illinois Department of Atmospheric Sciences, we have long maintained a synoptic lab facility. We faithfully printed and hung thousands of pages of paper maps on the walls in neat rows. At one time the meteorological data products represented on the maps could only be obtained there or at a facility like it.

However, with the advent of the web and the explosion of desktop computers, alternatives to these maps became available. One could increasingly access this data directly from one's desktop without any need for a trip to a specialized facility. And so, as time went on, we gradually reduced the number and kind of maps we printed. People visited the room less frequently and eventually we could no longer justify the cost or effort to print any of the maps. Without the maps the room no longer really had a purpose.

The nearly ubiquitous access to meteorological products via the web is generally a good thing and we've spent considerable effort in developing our own such resources as previously reported[1]. However, we now realize that there are several beneficial aspects of the old paper "map wall" that have been lost in the process:

- Human interaction: Of primary concern to us, is that individual users, each in their own office at their own computer, aren't as likely to engage in the spontaneous discussions that used to occur when multiple people happened to be examining the old map wall at the same time. In this way students and faculty were more likely to exchange ideas and pose questions to each other about what they were looking at. Though not formalized, it was never the less a valuable form of interaction and instruction.
- Easy browsing and comparison: The many rows of paper maps were easy to browse quickly and allowed rapid comparison of multiple plots viewed side by side. Side-by-side comparison of several model forecasts and observations, or differences amongst model forecasts is not readily possible on a single monitor due to the limited viewing area available.
- Discovery and Engagement: With research tasks to do and course work emphasis on theory, we often find students don't take time to take an interest in current synoptic events. Users are less likely to take an interest in and engage in a casual initial discovery process about the current status of the atmosphere using web-based solutions because it takes some action on their part. In contrast, a passive display in a public area is more likely to engage a person in initial discovery. For example, a busy student not keeping close tabs on the weather may be surprised to see a strong line of

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[1] http://ww2010.atmos.uiuc.edu/abt/pubs.rxml

storms across the Midwest when glancing at a radar display on their way to get some lunch. This passive initial discovery is likely to engage them in some more interactive additional exploration of the situation at hand. However, although a web page showing the same radar map is readily available to the same student on their desktop by way of only a few mouse clicks, they are less likely to make this initial discovery because it requires a conscious initial effort on their part, however small.

Of course, we recognize that the old way of doing things was very limited in other ways compared with modern capabilities and we're not at all proposing to do away with the web and go back to paper maps. Instead we have attempted to combine the best features of both in a revitalized, technologically up-to-date synoptic lab.

2. GOALS

The goal of our synoptic lab revitalization project is to create an engaging public space where students, staff, faculty and other visitors can interact with each other while passively and interactively exploring current meteorological data using *unique* electronic displays.

The word "unique" is a key factor here. Simply putting some computers in a room does not make it an effective high-tech synoptic lab. Most of our users already have good computers on their desktops…there's nothing special about going to the synoptic lab to use a computer to make a forecast. In order to get users to make a special trip there where the desired interaction can occur, the lab facilities need to have capabilities beyond what they have on their desk.

The facility should be able to host our newly reinstituted daily weather briefings and small classes. The use of the facility for non-synoptic activities such as for research group meetings and studying is also encouraged to further promote interaction.

In many respects, the goal is not so much a technological achievement, but the use of technology in combination with a facility to revitalize student interest in real-time synoptic meteorology and discussion of such.

3. FACILITY COMPONENTS

3.1 DISPLAY WALL

Central to and most visible to anyone walking by the new lab facility is a display wall consisting of fifteen 17" flat panel LCD screens arranged in a 5x3 array. Intended to display discrete images rather than a single composite image and therefore not joined seamlessly, these are an electronic version of the rows of old paper maps. The displays feature a wide variety of meteorological analysis, plots, maps, images and forecasts. Each can be customized and animated. A default configuration of images of general weather interest (current radar, satellite, surface observations, etc) is normally presented. This default display setup is automatically activated when nobody has interacted with the system for a period of time. It is designed to be colorful and visually interesting as well as informative to draw any visitors.

A touch panel screen in front of the array allows a user to switch the display wall into other predefined configurations of image displays or "channels" for forecasting, severe weather monitoring and so forth with a single touch.

For further customization, a more advanced user can use the touch panel menus to individually customize each display on the fly, and includes the ability to derive fields and save their preferences for later use.

Voice activated control has been considered, but preliminary research indicates that although the technology has come a long way, it is not sufficiently accurate in recognizing a wide variety of speakers.

We had a false wall built about 18" in front the real wall on one side of the room. On this wall are mounted the fifteen displays, which are driven by four powerful Linux-based servers located behind the wall. The wall also serves to conceal the abundant wiring and muffles the majority of noise generated by the servers. Each server has multiple video outputs and is responsible for driving up to four of the LCD panels.

The LCD displays are high-end 17" LCD desktop displays with the desk pedestals removed and wall mounted on adjustable brackets. We carefully chose displays that have an exceptionally wide viewing angle (140° in both the horizontal and vertical directions) to avoid the severe off center viewing limitations common in older LCD displays.

Because no software existed to operate such a system, we had to custom design software for it. This has posed the most significant challenge of the project as considerable software development work has been necessary. The work is divided into several parts.

For interactive capabilities and especially performance reasons, we designed the display front-end around Macromedia's Flash[2] technology. Although largely used for animated web banner ads and online games,

[2] http://www.macromedia.com/software/flash

there is much untapped potential in this technology for use in scientific displays. We've discovered that we can use it as a very efficient and fast graphics display engine for vector graphics (which is what most weather maps are). Of particular usefulness is its ability to overlay graphics. The display front end is essentially just the Macromedia Flash viewer running in a full-screen window on each display. There are hooks in its programming language that allow us to send it external commands to cause it to load up new overlays, start animations, etc. A sockets-based message routing system transmits XML-encoded messages from the touch screen menu and control system to the displays.

Because Flash is also a web-based medium, the system should be readily extensible to a web-based format at well.

When a particular overlay, image, background map, plot, etc. is requested by the front end, a locally developed weather graphics engine on the back-end rapidly generates the necessary graphics in SWF (Flash) format. This engine employs the NCAR Graphics[3] library for its mapping, contouring and other capabilities. A graphics driver based on the Ming [4] library was added to allow output to SWF format. The definitions of specific products layouts, contour intervals, color tables, etc. are defined using XML. A caching system avoids repeating time-consuming regeneration of graphics that need to be used more than once.

A data management system that employs Sleepycat Software's Berkely DB[5] database is used to store ingested raw data from the Unidata IDD data stream on a 240GB disk array and make it readily available to the rest of the system.

3.2 WORKSTATIONS

Because users will have a need to access other interactive meteorological software, web resources and other tools, we have provided several high-end PC-based workstations. (We use the term high-end loosely because it is such a rapidly moving target, but we plan to keep these systems up to date). These are equipped to dual boot into Windows 2000 or Linux.

Again, because it needs to be something more than users already have access to on their desks, these are each equipped with dual 19" displays. Combined with the close proximity of the workstations to each other, these displays provide an exceptional amount of screen real estate on which to open many web pages or other things to look at side by side.

3.3 OTHER COMPONENTS

Several other items, though hardly high-tech, were considered essential elements in setting up this synoptic lab facility.

- Projection System: Although becoming fairly commonplace in lecture rooms now, we considered the addition of a ceiling mounted LCD projector to be a critical necessity in our new lab. Connected to one of the workstations, this is used for the daily weather briefings and also during group meetings.
- Weather Station: Because weather observation starts just outside the window (and our new lab location actually has windows now!) we've invested in a new weather station. Because previous weather stations we've had were plagued by poor sensor location due to cabling limitations and frequent lightning damage, we decided to go with a wireless model to give us more flexibility in sensor placement to alleviate these problems.
- Furniture: The room includes two large tables with chairs…a good place to have a small meeting, study or maybe eat lunch. A whiteboard is available.
- Lighting: Although the original office style florescent fixtures are still in place, they can be turned off in favor of newly installed track lighting with dimmer switches. This reduces glare on the screens and gives the room a high-tech look.
- Televisions: Two large TV's are also in the room and can be tuned one to the Weather Channel and the other to Headline News for example… yet another reason to poke one's head into the room.

4. CONCLUSIONS

Parts of the lab were still being completed at the time of this writing. Further evaluation as to how successful we've been in achieving our goal will be needed. Thus far, the new daily weather briefings that we've been able to hold there have been well attended.

The total budget for setting up the lab was approximately $50K of internal funding. Of this, the two largest components were the display wall, which cost approximately $30K and the necessary modifications to the room (electrical carpentry, etc) at about $10K.

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[3] http://ngwww.ucar.edu/
[4] http://www.opaque.net/ming
[5] http://www.sleepycat.com/