Hurricanes in Wisconsin

John Gravelle

At 5:05 AM local time, Hurricane Andrew began destroying property and lives in Dade county Florida. On August 10th, Hurricane Allen slammed into Brownsville, Texas. In 1969, Camille laid death and tragedy upon the people of Mississippi. Diane in ’55, the Labor Day storm of ’35, the September 8th hurricane of 1900, and many others are remembered by those whose lives are affected by hurricanes.

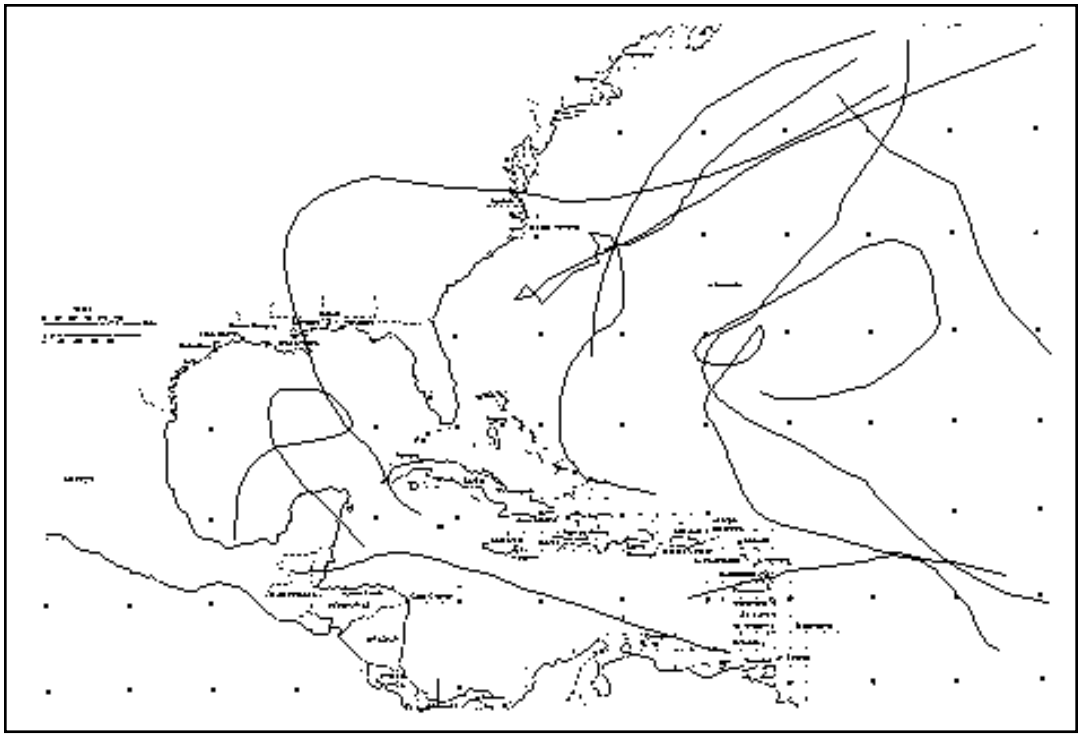


Figure 1. Hurricanes of 1969

The warm, moist ocean air spirals into the eyewall of a hurricane. As this air rises, the water vapor condenses and releases heat that continues to add to the strength of the hurricane. As the eyewall moves across land, vortices are created, local tornadoes really, with winds reaching 200 miles/ hour. These vortices can leave paths of destruction 50 to 300 feet wide.

Hurricanes are one of nature's most feared displays of power. To the people of the Atlantic and Gulf coasts, hurricanes destroy property and lives and therefore are a major force and interest. Yet Merrill, Wisconsin is often affected by the strong winds from these storms of Nature.

Church Mutual is a small insurance company, yet to the people of Merrill, Wisconsin it is the largest employer. Church Mutual insures churches and religious facilities around the country. Church Mutual insures many churches in Florida and other states along the Atlantic seacoast. Hurricanes are very important to Merrill.

In November of 1992, Randy Brandner a vice-president with Church Mutual, called and asked if I could find any information concerning the Atlantic Hurricanes. He was interested in all hurricanes during the 20th century. Church Mutual is interested in the paths and strengths of the hurricanes and the theories that have been proposed. Randy indicated that they had not found a source of maps or data and wondered if the Internet might contain the information.

Four days later, I handed him a file containing detailed information on all hurricanes from 1886 through 1993.

This one example typifies the power and the future of the Internet. The Supercomputer Centers, DOE, NSF, and others have created an information arena that will be seen as one of the major contributions of the late 20th century.

The Internet gave me the data, but it is computers that will allow us to understand the data. I suggested to Randy that my high school students create a hypercard stack that would plot hurricanes. Florida is of special interest and Randy wanted the capability to plot any group of hurricanes on the same map. We began the process to create the stacks.

In December, Dr. Craig Mattocks, from the National Hurricane Center of the NOAA was very helpful. He placed the raw data on a public portion of his server. I then FTPed to his site and copied the 700k file to the Cray X/MP that is part of the National Education Supercomputer Program at Lawrence Livermore National Labs. File transfer was about 2 seconds. From the Cray, I then downloaded the file to my Macintosh LC. This took 30 minutes. Same file, but at two very different transfer rates. I started my Word processor and opened the file. There, I found line after line of numbers. A small portion of the file follows:

```
00010   06/13/1886    M= 3     1      SNBR= 1      NOT  NAMED    XING=1   SSS=9
00020   06/13*  0      0    0    0*232    957   35     0*  247    959    40    0*  260    960   45    0*
00030   06/14*269    958   45    0*279    954   50     0*  289    946    50    0*  298    938   50    0*
00031   06/15*304    928   50    0*309    918   35     0*    0      0     0    0*    0      0    0    0*
00034   TS
00040   06/18/1886    M= 6     2      SNBR= 2      NOT  NAMED    XING=1   SSS=9
00050   06/18*  0      0    0    0*194    850   35       0*198    853    50      0*201    856   65    0*
00060   06/19*204    858   70    0*208    861   75       0*214    864    80      0*218    865   80    0*
00070   06/20*224    868   85    0*232    869   85       0*242    870    85      0*254    868   85    0*
00080   06/21*267    864   85    0*280    857   85       0*294    850    85      0*308    843   75    0*
00090   06/22*323    832   50    0*338    822   40       0*352    810    35      0*363    793   35    0*
00100   06/23*373    780   35    0*384    769   35       0*393    753    35      0*399    732   35    0*
00103   HR
00110   06/27/1886    M= 6     3      SNBR= 3      NOT  NAMED    XING=1   SSS=9
00120   06/27*  0      0    0      0*      0     0     00*170    801    35      0*176    823   45    0*
00130   06/28*183    842   65    0*191    859   80       0*200    871    85      0*211    881   80    0*
00140   06/29*223    882   80    0*235    883   85       0*247    884    85      0*255    881   85    0*
00150   06/30*260    878   85    0*266    875   85       0*273    869    85      0*282    859   85    0*
00160   07/01*289    848   85    0*309    828   80       0*324    818    60      0*338    803   45    0*
00170   07/02*349    791   40    0*361    780   35       0*372    770    35      0*382    753   35    0*
00173   HR
00180   07/14/1886    M= 7     4      SNBR= 4      NOT  NAMED    XING=1   SSS=9
00190   07/14*  0      0    0    0*189    829   35       0*192    834    40      0*197    839   40    0*
00200   07/15*202    844   45    0*207    850   50       0*213    855    55      0*219    861   60    0*
00210   07/16*226    868   65    0*234    875   70       0*241    881    75      0*251    883   75    0*
00220   07/17*260    883   80    0*270    882   85       0*274    876    85      0*277    869   85    0*
00230   07/18*278    860   85    0*279    851   85       0*281    843    85      0*286    832   85    0*
00240   07/19*291    824   85    0*299    813   80       0*305    803    75      0*312    792   70    0*
00250   07/20*319    781   70    0*328    770   70       0*338    758    70      0*347    738   70    0*
00253   HR
```

Dr. Mattocks also sent the file and record structure. Following is the format:

I. Header Record Format

Columns	Contents
1 - 5	Card Sequence Number
7 - 8	Month
10 - 11	Day (first day of storm on record)
13 - 16	Year
20 - 21	Value of M (M = number of days storm existed)
23 - 24	Storm number for that year
31 - 34	Cumulative storm number
36 - 47	Storm name
53	Crossing (1 = hit US coastline; 0 = did not)
59	Saffir/Simpson hurricane scale number
80	Last storm of year if L

II. Data Record Format

Columns	Contents			
1 - 5	Card Sequence Number			
7 - 8	Month			
10 - 11	Day			
12	Storm type	at	00	Z
13 - 15	Latitude	at	00	Z
16 - 19	Longitude	at	00	Z
21 - 23	Wind Speed	at	00	Z
25 - 28	Central Pressure	at	00	Z
29	Storm type	at	6	Z
30 - 32	Latitude	at	6	Z
33 - 36	Longitude	at	6	Z
38 - 40	Wind Speed	at	6	Z
42 - 45	Central Pressure	at	6	Z
46	Storm type	at	12	Z
47 - 49	Latitude	at	12	Z
50 - 53	Longitude	at	12	Z
55 - 57	Wind Speed	at	12	Z
59 - 62	Central Pressure	at	12	Z
63	Storm type	at	18	Z
64 - 66	Latitude	at	18	Z
67 - 70	Longitude	at	18	Z
72 - 74	Wind Speed	at	18	Z
76 - 79	Central Pressure	at	18	Z

This is an older format that depends on character position. Each hurricane is dated. The storm's latitude, longitude, wind speed, and central pressure are recorded four times per day. Times are Zulu, and speeds are in knots.

I then proceeded to place the data into a HyperCard (HC) stack. I created cards for each year from 1886 to 2000. I named the cards "Date XXXX". The following script took chunks of data from the hurricane file and placed it in the correct year. This was keyed to the 13th - 16th characters of the record header, where the year appeared. I knew I was reading a record header if the 26th - 29th characters of the line were "SNBR."

```
on mouseUp
    —set lockscreen to true
    —put “NL” into vLast
    —go card “Date 1886”
    —put 1 into vBegin
    put 450000 into vBegin
    open file tx
    read from file “tx” at vBegin for 100
    put offset(return,it) into vChars
    put vBegin + vChars into vBegin
    repeat
        read from file “tx” at vBegin for 16000
        if it is empty then exit repeat
        repeat
            put offset(return,it) into vChars
            if vChars = 0 then exit repeat
            put char 26 to 29 of it into vSNBR
            if vSNBR = “SNBR” then
                put char 13 to 16 of it into vDate1
                put “Date ”&vDate1 into vDate
                go card vDate
                put vDate into msg box
            end if
            if vDate1 > 1967 then
                put char 1 to vChars of it after fld 1
            end if
            delete char 1 to vChars of it
        end repeat
        put length(it) into vLength
        put vBegin + 16000 - vLength into vBegin
    end repeat
    close file “tx”
end mouseUp
```

Three occurrences important to education then took place.

First, I assigned the problem to my students. Their job was to use the data in my stack and plot hurricanes.

Rich Enderton from Minnehaha Academy in Minnesota has been both mentor and collaborator. I told him about the project and he graciously offered to have his students use the net to download images of famous (and some not so famous) hurricanes. Our students have never met, but they are working on different aspects of the same problem.

How and where is Rich's story. He will have some of the more historic images placed on high quality film and we will be showing them in presentations.

The third occurrence involves fifth grade children. I felt we needed a "quality assurance check" of the Hypercard stack. We needed some way to see if what was plotted was truly representative of the hurricane data.

Again Dr. Mattock was helpful. He sent me maps of the Atlantic seacoast that contained latitude and longitude markings. We copied the maps and asked fifth grade teachers if they would have students plot by hand some hurricanes from the different decades. We will then compare the high school maps to those of the fifth grade. Any major discrepancies will be examined to see if the programming logic is faulty or if the fifth grader plotted incorrectly.

This is a project-in-progress. Regardless of its actual value to Church Mutual, I see that it has been a very valuable educational experience. The ability to take data and display it is useful, but it is the mathematics and programming elements that makes this a success.

In plotting the data on a HC card, my students ran smack into a math problem.

Screen coordinates are in pixels with 0,0 in the upper left corner. Positive X moves across and positive Y moves down. On the map, Longitude values increase moving left and Latitude values increase going up.

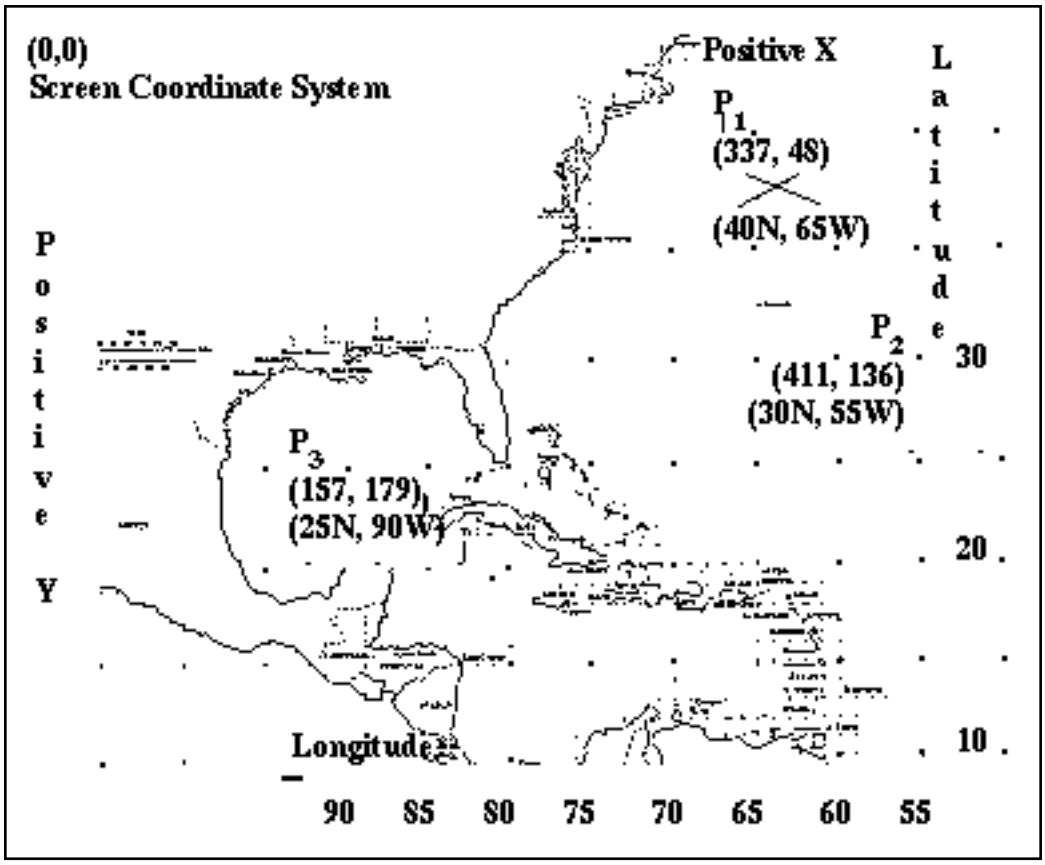


Figure 2. Longitude, Latitude, and Screen Coordinates

It was necessary that students found functions that would relate these two coordinate systems. I was also discussing linear equations in Algebra II.

Using the xy command in HC, one can identify pixel locations on a card. I required students to create two separate tables. The first table showed the x pixel value with the longitude value marker on the map that was in the background of the card. The second table related the y pixel value to the latitude value.

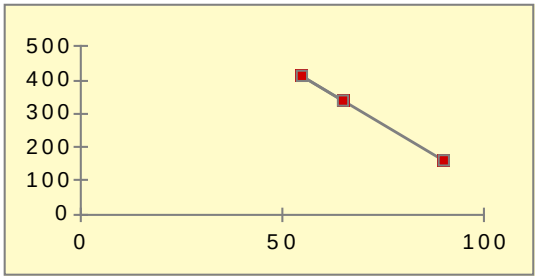
Table 1

Latitude	Y Pixel Coord.
P1 40	48
P2 30	136
P3 25	179

Table 2

Longitude	X Pixel Coord.
P1 65	337
P2 55	411
P3 90	157

Using the first table, students were asked to plot the ordered pairs. As luck would have it, the table was highly linear. They then plotted table 2.



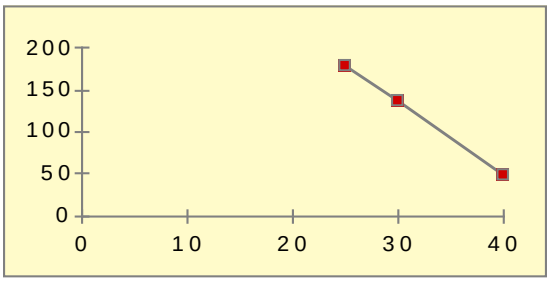


Figure 3. Plots from Tables 1 and 2

Students then were asked to find the equation of the line using the 2-point and the point/slope equation of a line: $y - y_1 = m(x - x_1)$.

$$y - y_1 = m(x - x1)$$

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

$$m = \frac{157 - 337}{90 - 65}$$

$$m = \frac{-180}{25}$$

$$m = -7.2$$

$$y - 337 = -7.2(x - 65)$$

$$y - 337 = -7.2x + 468$$

$$y = -7.2x + 805$$

$$y - y_1 = m(x - x_1)$$

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

$$m = \frac{179 - 48}{25 - 40}$$

$$m = \frac{131}{-15}$$

$$m = -8.7$$

$$y - 48 = -8.7(x - 40)$$

$$y - 48 = -8.7x + 348$$

$$y = -8.7x + 396$$

It must be noted that there was considerable confusion over the meanings of x and y in the above problem. Because math teachers tend to use x and y for the cartisian coordinate system, the students were confused with the x-pixel, longitude value coordinates and also the y-pixel, latitude coordinates. Mathematics teachers must spend more time showing coordinate problems that are NOT in the normal 4-quadrant position.

These equations were given to the programmers who then were responsible for making them into functions (as in computer language function).

```
function ConvertLat vLat
    put Round(-8.7*vLat + 396) into y
    return y
end ConvertLat

function ConvertLong vLong
    put Round(-7.2*vLong + 805) into x
    return x
end ConvertLong
```

These two simple and innocent looking functions consumed weeks of high school students math and computer science time. But without them, one could not plot hurricanes!!

With the data and functions, a simple script allowed us to put all hurricane data into screen values that were related to the background map of the eastern US.

```
on mouseUp
    set lockscreen to true
    repeat with vYear = 1886 to 1993
        put vYear into the msg box
        go card "Date "&vYear
        select text of fld "HR"
        put the selectedText into vTemp
        put number of lines of fld 3 into vNumberOfHR
        —this repeat tells how many HR in a specific year. It will
        —pass through each set of hurricane data
        repeat with vNumHR = 1 to vNumberOfHR
            put line vNumHR of fld 3 into vPointer
            put item 1 of vPointer into vStart
            put item 2 of vPointer into vLast
            put line vStart of fld 1 into vRecord
            put char 7 to 16 of vRecord into vDate
```

```
                put char 36 to 47 of vRecord into vName
                put vDate&“,”&vName&return after fld “Position Data”

                —This repeat will get the second record through the second
                —to the last record of a single hurricane data

                repeat with vX = vStart +1     to vLast -1
                    put line vX of fld 1 into vLineData
                    —the following repeat will do all lat and long
                    — values for a Hurricane and places the pixel results in
                    — cd fld pixels
                    repeat with vPos = 1 to 4
                        put 17* vPos into vX1
                        put char vX1 to vX1 +2 of vLIneData into vLong1
                        put vLong1/10 into vLong1
                        put ConvertLong(vLong1) into x1
                        put 17*vPos -4 into vY1
                        put char vY1 to vY1 +2 of vLIneData into vLat1
                        put vLat1/10 into vLat1
                        put ConvertLat(vLat1) into y1
                        put vLat1&“,”&vLong1&“,”&x1&“,”&y1&return
                            after fld “Position Data”
                    end repeat  — vPos
                end repeat  — vX
            end repeat  — vNumHR
        end repeat  — vYear
    end mouseUp


    function ConvertLat vLat
        put Round(-8.7*vLat + 396) into y
        return y
    end ConvertLat

    function ConvertLong vLong
        put Round(-7.2*vLong + 805) into x
        return x
    end ConvertLong
```

Then, another script can use the pixel data, a plot command, and appropriate domain and range restrictions to plot hurricanes.

```
on mouseUp
    repeat with vYear = 1886 to 1992
        go card “Date ”&vYear
        select text of fld “Position Data”
        put the selectedText into vData
        go back
        doMenu “New Card”
        set the name of this card to “Plot ”&vYear
        put vData into fld temp
        —now let’s plot the hurricane
        choose brush tool
        put number of lines of fld temp into vLines
        put line 1 of fld temp into vLoc
        put item 2 of vLoc into vTemp
        put 2 into vPixelLines
        put line vPixelLines of fld temp into vLoc
        put item 3 of vLoc into x1
        put item 4 of vLoc into y1
        put vPixelLines + 1 into vPixelLines
        put “T” into vDraw
        repeat while vPixelLines < vLines
            choose brush tool
            put line vPixelLines of fld temp into vLoc
            put item 2 of vLoc into vTest
            if CharToNum(vTest) > 57 then
                put vtest into the msg box
                put vPixelLines + 1 into vPixelLines
                put item 3 of vLoc into x1
                put item 4 of vLoc into y1
            else
                put item 3 of vLoc into x2
                put item 4 of vLoc into y2
                if x1 < 1 or x1 > 500 then
                    put x2 into x1
                    put y2 into y1
                    put “F” into vDraw
                end if
                if y1 < 1 or y1 > 330 then
                    put x2 into x1
                    put y2 into y1
                    put “F” into vDraw
                end if
                if x2 < 1 or x2 > 500 then
                    put “F” into vDraw
                end if
                if y2 < 1 or y2 > 330 then
```

```
                    put "F" into vDraw
                end if
                if vDraw <> "F" then
                    drag from x1,y1 to x2,y2
                    select fld "Info"
                    domenu "Copy Field"
                    domenu "Paste Field"
                    put "Location" && x1 && y1 into vName
                    set the name of cd fld "Info" to vName
                    set the topleft of cd Fld vName to x1, y1
                    put vTemp into cd fld vName
                    put x2 into x1
                    put y2 into y1
                end if
            end if
            put "T" into vDraw
            put vPixelLines+1 into vPixelLines
        end repeat  — vPixelLines
    end repeat  — vYear
end mouseUp
```

The lack of comment lines is a critical problem to me. Though I stress the importance of internal documentation, students ignore my rantings and develop code that is poorly documented. In their defense, this is early code and the final versions should be better documented. My concern is they will forget what different parts of their scripts do even while they remember all the teams in the Sweet 16 from 1990.

The previous scripts produce maps like the following:

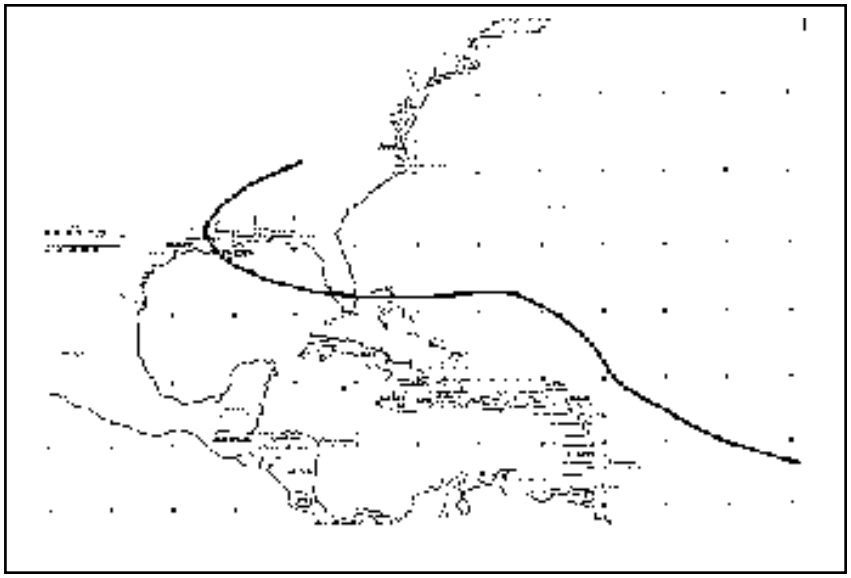


Figure 4. Sample of Map Produced from the Scripts

This is the path of Hurricane Andrew in late August of 1992 as it moved through the Atlantic and Gulf waters. Its reckless behavior over land was a major concern to us.

The easy part is over. Students are now working on the user interface. They are adding useful information. It is possible to identify windspeeds by passing the mouse over the path. They are looking at different ways to display the time and date. Zulu time has caused big problems. We see no simple solutions for converting Zulu time dates to eastern time dates. The time is easy but the day is tough. Every month ought to have the same number of days!!!

Because Florida is the main interest of Church Mutual, we plan to have three levels of magnification, each focusing more tightly on the Floridian coast. This means new functions for the map latitude and longitude and the screen pixels. This means new plots, more complication and, for me, the enjoyment of watching students handle real problems and solving them.

Special thanks must be given to Dr. Craig Mattocks for the data and maps. Without them and the record information we would not have been able to do this project.

Rich Enderton will be supplying images of hurricanes. The Internet again is used to supply information to students.

To the fifth grades - THANKS. It is essential that computer programs be tested. You are the quality assurance group.

And finally, thanks to NESP. Without access to the computers on the Internet, Merrill High School and the Minnehaha Academy could not be working on such exciting projects.

ADDENDUM

[Following is a summary of the project presented as an entry into a project competition.]

1. **TITLE OF ENTRY:** Hurricanes in Wisconsin

2. **NAME OF ENTRANT:** John D. Gravelle

3. **ENTRY CATEGORY:** Education

4A. **NAME:** John D. Gravelle
4B. **ORGANIZATION:** Merrill Senior High
4C. **TITLE:** Teacher
4D. **ROOM/MAILSTOP:** Room 211
4E. **ADDRESS:** 106 Polk Street
4F. **CITY:** Merrill
4G. **STATE:** Wisconsin
4H. **ZIP:** 54452
4I. **PHONE:** 715-536-4594
4J. **FAX:** 715-536-5504
4K. **EMAIL:** gravelle@cedar.cic.net

5. **DATE OF FIRST USE:** December 1993

6A. **# OF USERS:** 40
6B. **DESCRIPTION OF USERS:** High School Students in Algebra II and Computer Science. The lesson was used from November ’93 through May of 1994.
6C. **# OF SITES:** 1
6D. **NETWORKING:** Students used networked modems (AppleTalk) to connect to the net via Cray x/mp (migrated to y/mp) at Lawrence Livermore National Laboratory. Unix tools were used to obtain data from the net.
6E. **VERIFICATION:** Yes

6F. **VERIFICATION METHOD:** Please visit our school to see our students use the net. Our access is limited, but some can still find ways out.

7. **SUMMARY DESCRIPTION:** Hurricane data is available on the net. Merrill students used the net to retrieve information that allowed them to plot any Atlantic hurricane. This information was given to Church Mutual Insurance Company: Merrill's largest employer insures churches throughout the United States; even in hurricane country!!

8. **DEMONSTRATES NII CAPABILITY AND UTILITY:** Church Mutual could not locate a source of all hurricane data in the 20th century. We were able to contact the National Oceanic and Atmospheric Administration (by e-mail) and received the data via the net. It took 2 seconds to transfer the 700k data file from NOAA to the Educational Cray at Lawrence Livermore National Laboratory. It then required 30 minutes to transfer the information to our Macintosh. It is interesting that the information travelled from Florida to California to Merrill, Wisconsin in 30 minutes and 2 seconds.

Again using e-mail, Dr. Craig Mattocks (NOAA) helped us decipher the file structure so that we could place the data into HyperCard. Students also used the net to pinpoint Atlantic coast cities' latitude and longitude positions very accurately.

Dr. Mattocks supplied us with Atlantic seacoast maps that we scanned into our Macs. We then needed to identify the relationship between pixel locations and latitude and longitude. This relationship was highly linear and allowed students to find linear functions that allowed our programmers to convert the longitude and latitude data into x,y coordinates. With appropriate domain and range controls, the hurricanes were plotted on the screen.

As a check on our program, we asked several 5th grades to plot by hand hurricanes from different decades. In Wisconsin, 5th grade is the year that latitude and longitude are taught. US geography is also a major subject in the 5th grade. The 5th graders also found it interesting how the naming of hurricanes changed over the decades.

9. **PRACTICAL:** This project is easily replicated by schools on the net. It is not a "bandwidth hog" and only requires that a school have a 2400 baud modem or faster and an account on the net. The data file was ftped and the latitude and longitude position of cities were attained via telnet.

   In this Goals 2000 era, it satisfies many of the objectives:

   a) Strong school/business relationship. Church Mutual was very impressed with the speed and quantity of information.

   b) Cross-discipline curricula: Algebra students, Computer Science students, and 5th graders needed to work on this project to make it succeed.

   c) Strong math concepts: The creation of linear functions was not a trivial problem for our students. We did not supply them with the functions but coerced them (as gently as possible) into discovering the relationship between classroom instruction about the point/slope formula and the latitude/longitude - x,y pixel display of the computer screen.

   This project can and will be used again. Each year, a new group of students will be asked to solve the problem.

   The project can also be directly adapted to other phenomena. Tornado data can be found and plotted. The latitude and longitude epicenters of earthquakes can be plotted and the concentric rippling can be shown in HyperCard. Tsunamis would be of interest to students on the west coast and Hawaii. Moonquakes, Marsquakes, or eruptions on Io need to be explored and plotted by our students.

   I am sure that the NOAA, DOE, NASA, and DoD would be happy to supply our children with the appropriate data. And all would do this via the net.

10. **ENCOURAGES USE OF THE NII:** Simply stated, this could not have been done without the NII. 700 thousand characters of information can not be handled, transferred, or digested in a classroom. The logistic notwithstanding, no teacher would have the time in his/her curriculum to devote to this.

    But the net allows classroom teachers to take actual data and use it within the curriculum and, with the aid of computers, let students solve "real" problems.

With very little instruction, students and teachers can learn to ftp and telnet. If they have Mosaic or a www line browser, they can navigate and retrieve the information even without instructions.

Yet the aim of this project was not to make things simple. The net and computers will allow our students to do things that were never possible before. Visualization is becoming an important science. Information is the crest of the next wave. Our children must know how to visualize and gather information if we wish to continue moving forward as a nation. To leave our classrooms without phones, modems, networks, and computers is a disgrace to the PK-12 education system and the American public that supports us.

11. **REFERENCES:**

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Fax: (305) 536-6881
E-mail: craig@nhc-hp0.nhc.noaa.gov

12. **BARRIERS:** The obvious barrier is access to the net. I found it easier to use my computer, modem, and home phone, than try to use the equipment at school. It is a sad commentary on the state of Pk-12 funding when the DoE and DoD provide better access to the net than do the DoEd or local administrators. It took literally years to get access to a shared phone line and took only minutes for it to be removed from my classroom.

    This project requires students to do a fair amount of independent thinking. Many "gave up" after five minutes of thinking, not interested in approaching the problem from different angles nor interested in trying solutions that might be incorrect. "No time" is the broken record teachers hear over and over....

13. **ADVICE:** HyperTalk is not the only computer language that could be used. I would not recommend BASIC or Pascal since neither is used for any constructive purpose. Any object oriented language should work.

    A math teacher could easily team with a computer teacher for this project. Bringing in 5th grade teachers is a logistics problem that would need to be solved locally.

    Please don't give the students the functions. Don't "suggest" looking at two points. Give them the data and let them see the relationships. I had the students plot points in Microsoft Excel to see that the results were straight lines. I did not tell them that the results were linear. It was no coincidence that we were studying Linear functions at the time, but I did not say that the functions would be linear.

    The net contains data (information to the layperson). Yet we all need to learn how to navigate the net to find the data. But to use that data, we will need tools and we will need people to construct those tools. Let's not give up on the basics just yet; the toolmakers will need them.