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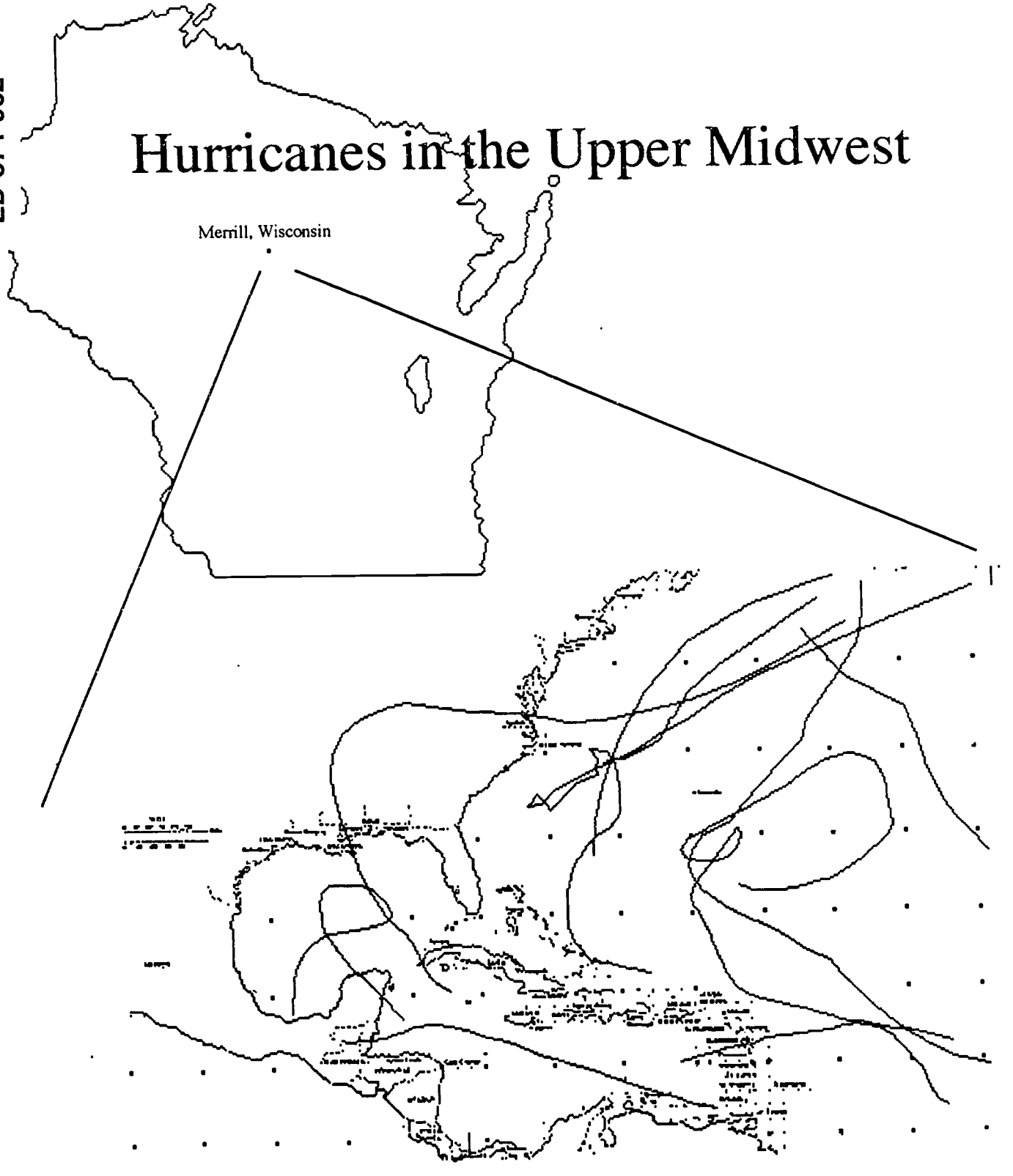
ABSTRACT

This document describes the procedures used by one group of Wisconsin high school students to compile data researched on all hurricanes in the Atlantic from 1886 through 1993. The students used data received on Internet to create a hypercard stack that would plot hurricanes. Students from Minnehaha Academy in Minnesota used the net to download images of famous (and not so famous) hurricanes. The Wisconsin students used linear equations to solve mathematical problems encountered while plotting hypercard data. Computer students at the high school were responsible for making the equations into functions (as in computer language functions). Students ignored the importance of developing computer code that is clearly documented. Fifth graders tested the computer programs. (AA)

# Hurricanes in the Upper Midwest



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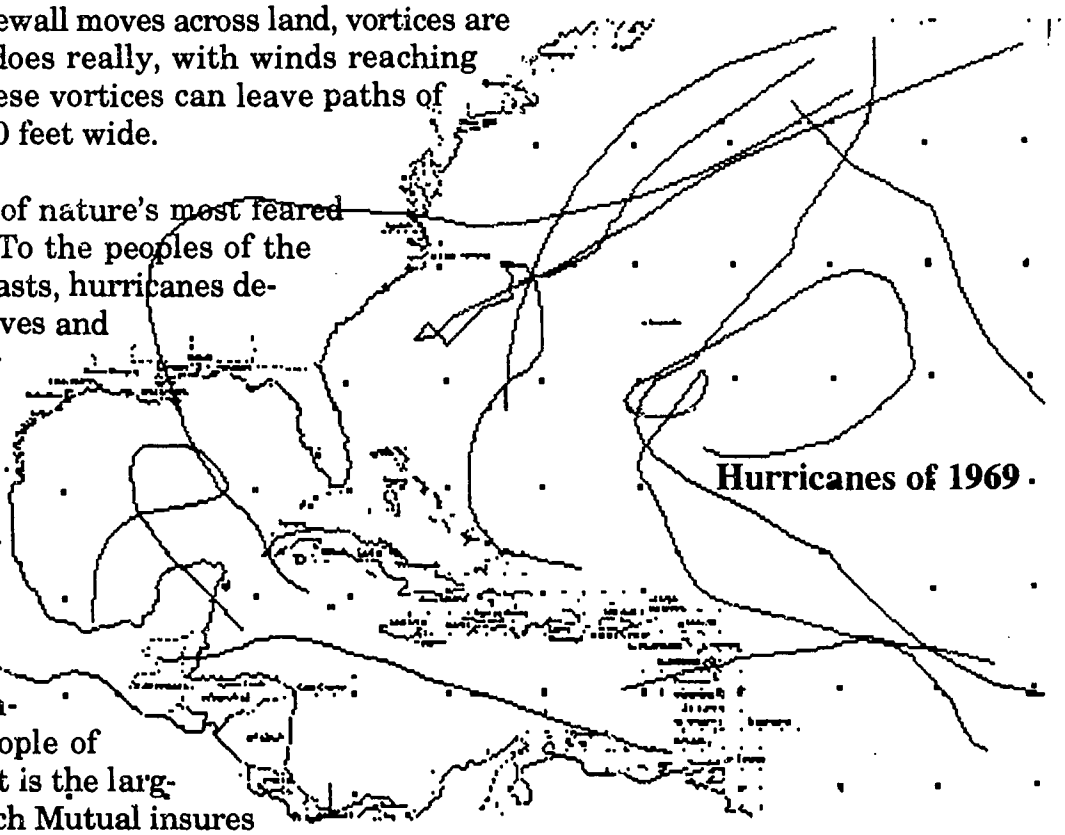
# Hurricanes in the Upper Midwest

At 5:05 AM local time, Hurricane Andrew began destroying property and lives in Dade county Florida. One August 10th, Hurricane Allen slammed into Brownsville, Texas. In 1969, Camille laid death and tragedy upon the peoples 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.

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 peoples 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 zdowned the file to my Macintosh LC. This took 30 minutes. Same file, but at two very different transfer rates. I started my Wordprocessor 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   0    0*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 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.

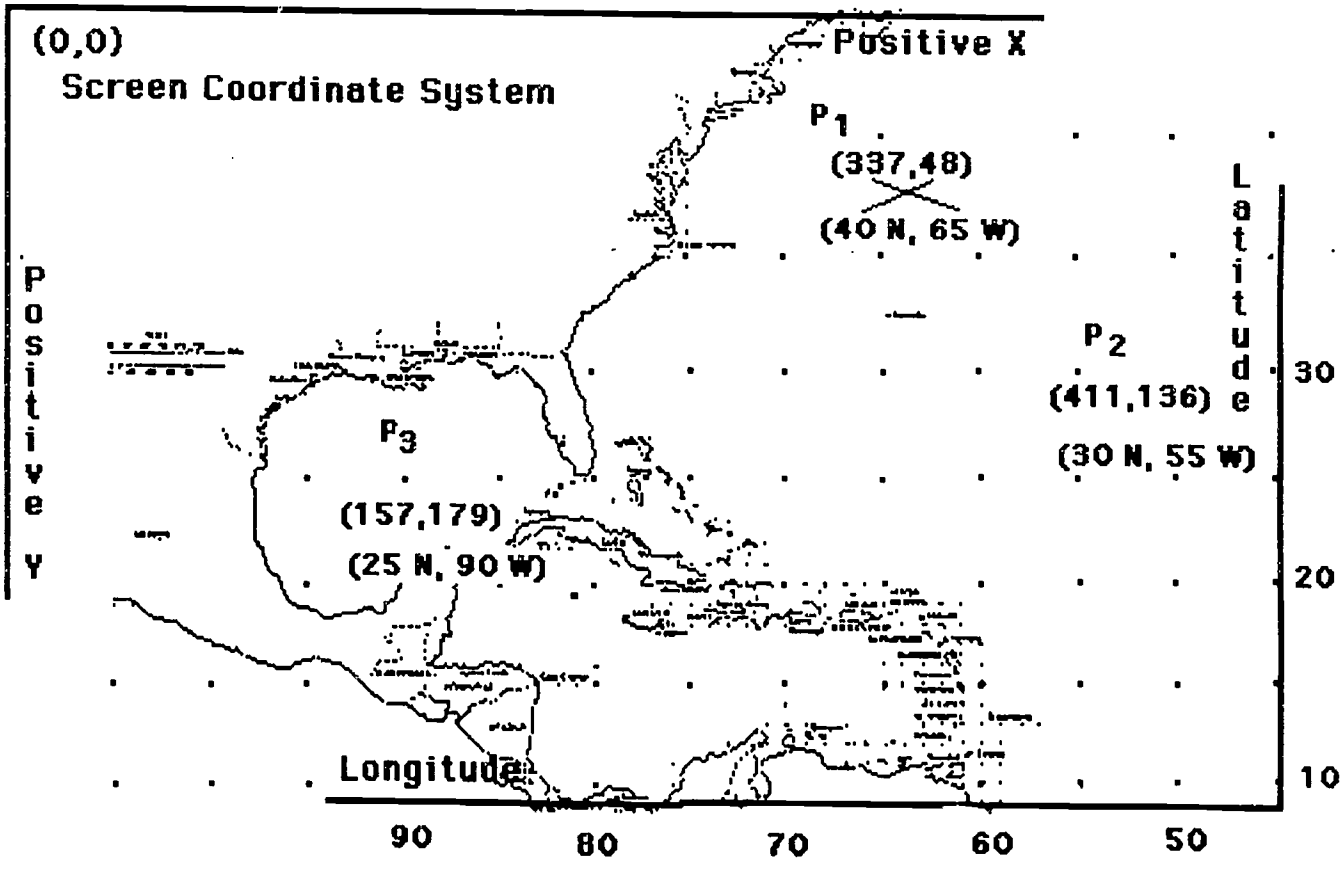
The third occurrence involves fifth grade children. I felt we needed a "quality assurance check" of the Hypercard stack. We needed some way to see if what was plotted was truly representative of the hurricane data.

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.



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.

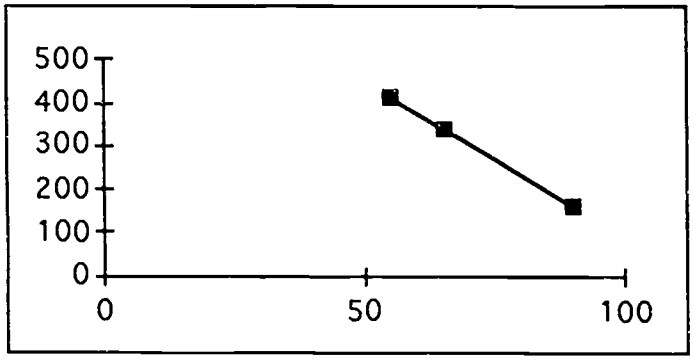
Table 1

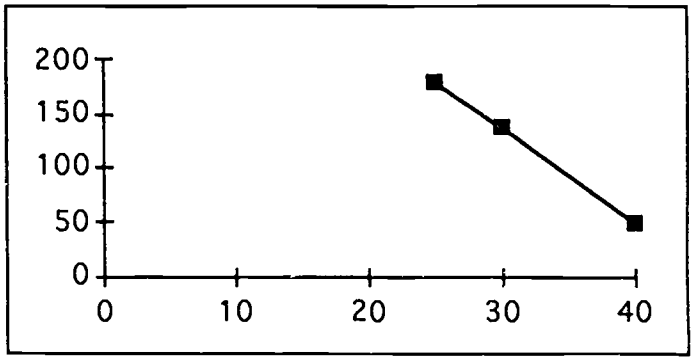
| | Longitude | X Pixel Coord. |
|---|---|---|
| P1 | 65 | 337 |
| P2 | 55 | 411 |
| P3 | 90 | 157 |

Table 2

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

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.




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

$$Y - Y_1 = m(X - X_1)$$

$$m = \frac{Y_2 - Y_1}{X_2 - X_1}$$

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

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

$$m = -7.2$$

$$Y - 337 = -7.2(X - 65)$$

$$Y - 337 = -7.2X + 468$$

$$Y = -7.2X + 805$$

$$Y - Y_1 = m(X - X_1)$$

$$m = \frac{Y_2 - Y_1}{X_2 - X_1}$$

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

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

$$m = -8.7$$

$$Y - 48 = -8.7(X - 40)$$

$$Y - 48 = -8.7X + 348$$

$$Y = -8.7X + 396$$

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
```

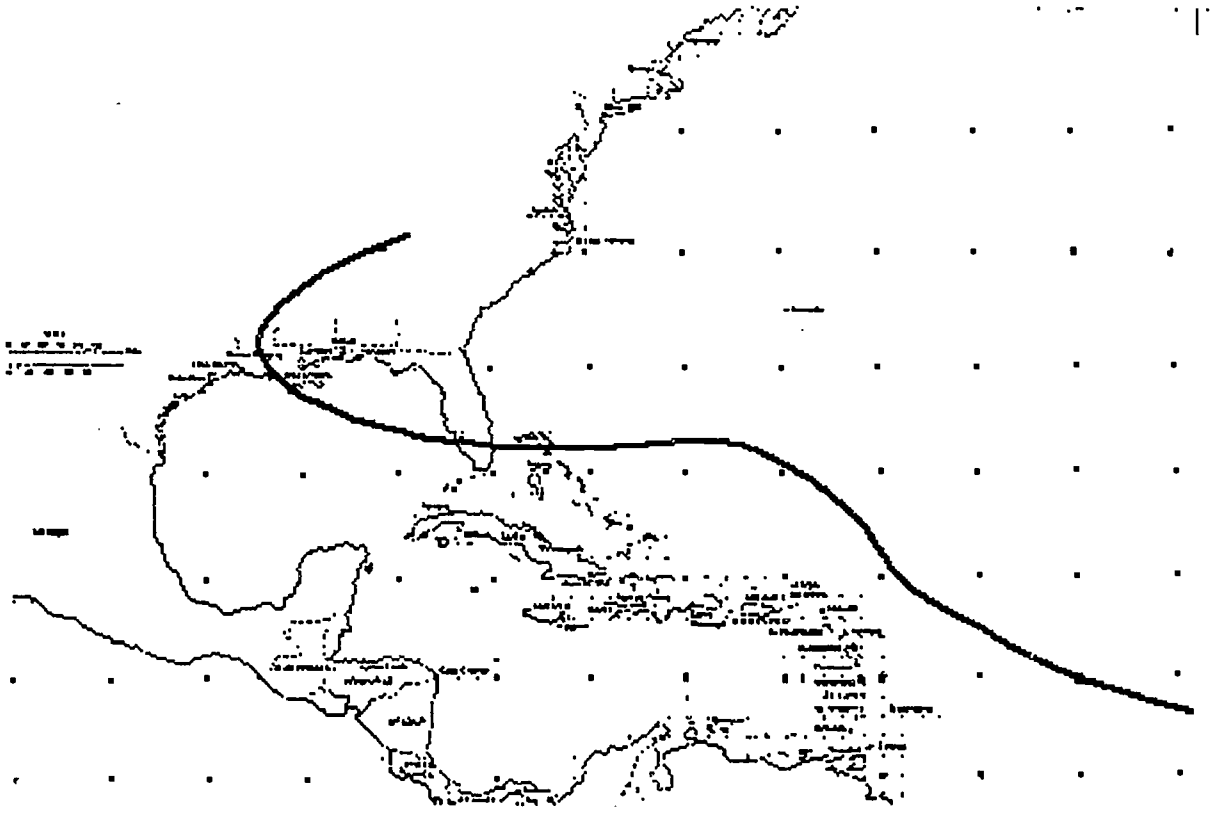
Then, another script can use the pixel data, a plot command, and appropriate domain and range restrictions to plot hurricanes.

```
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" intc 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:



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 focussing 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.