South Texas Interactive Nursing Geographic Information System

Graduate Project

by

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# TABLE OF CONTENTS

TABLE OF CONTENTS ........................................................................................................... ii
TABLE OF FIGURES ............................................................................................................. iv
ABSTRACT ............................................................................................................................... 1
BACKGROUND AND RATIONALE ......................................................................................... 2
   Metropolitan ......................................................................................................................... 2
   Rural ................................................................................................................................... 3
NARRATIVE .............................................................................................................................. 5
   User Interface ....................................................................................................................... 5
      STINGIS server functionality ......................................................................................... 5
      STINGIS client functionality ......................................................................................... 6
         Full Extent .................................................................................................................... 8
         Zoom In ...................................................................................................................... 8
         Zoom Out .................................................................................................................. 8
         Pan ............................................................................................................................. 9
         Layers ....................................................................................................................... 9
         Identify ...................................................................................................................... 9
         Query ....................................................................................................................... 11
         Remote map request ............................................................................................... 12
Databases Used for STINGIS Implementation ..................................................................... 13
   Texas State Data Center ................................................................................................. 13
   Reduced to GCBR 1990 Census ..................................................................................... 13
   1997 Board of Nurse Examiners ..................................................................................... 14
   Conversion to shapefiles ................................................................................................. 14
ENVIRONMENT ....................................................................................................................... 15
   Minimum hardware requirements for reliable operation of STINGIS ......................... 15
      Server-side .................................................................................................................... 15
      Client-side .................................................................................................................... 15
   Minimum software requirements for reliable operation of STINGIS ........................... 15
      Server-side .................................................................................................................... 15
      Client-side .................................................................................................................... 16
Languages and Object components used .......................................................................... 16
PROCEDURE ........................................................................................................................... 17
   1. Acquire a server and install Windows NT 4.0 ............................................................... 18
   2. Install Microsoft Internet Information Server ............................................................ 18
   3. Install ESRI MapObjects IMS extensions to the IIS ................................................... 19
   4. Convert Source Data for use in STINGIS ................................................................. 20
      4.1. BNE97 (7 records shown) ...................................................................................... 20
      4.2. ZIPs (8 records) ................................................................................................... 21
      4.3. Tracts (2 records): ............................................................................................... 21
      4.4. Counties (2 records) ............................................................................................. 22
   5. Build the client-side HTML application .................................................................... 24
   6. Build the server-side mapping application .................................................................. 27
      6.1. Cartographic organization of a map ..................................................................... 27
6.2. Orientation and coordinate systems ........................................ 30
6.3. Object organization ......................................................... 30
6.4. STINGIS Commands .......................................................... 33
  6.4.1. Full Extent ............................................................... 33
  6.4.2. Zoom In ................................................................. 34
  6.4.3. Zoom Out ............................................................... 34
  6.4.4. Pan ......................................................................... 34
  6.4.5. Layers ................................................................. 35
  6.4.6. Identify ............................................................... 36
  6.4.7. Query ................................................................. 37
  6.4.8. Help ................................................................. 38
6.5. Miscellaneous STINGIS Features ......................................... 39
  6.5.1. Extract map extent ................................................... 39
  6.5.2. Scale bar ............................................................... 40
  6.5.3. Remote map request ................................................... 41
  6.5.4. Clean up the old images ................................................. 41
7. Test the system ................................................................. 43
CONCLUSION/EXPECTED RESULTS .................................................. 45
REFERENCES AND BIBLIOGRAPHY .................................................. 46
Appendix A - Complete frmMain Form Code .................................... 48
  Private Sub Form_Load() ..................................................... 49
  Private Sub Form_Unload(Cancel As Integer) ................................ 49
  Private Sub WebLink_Request(ByVal arguments As Object, ByVal values As Object) ..................................................... 50
  Private Sub DoGIF(ByVal ext As MapObjects.Rectangle) ...................... 51
  Private Sub DoMap(ByVal ext As MapObjects.Rectangle) ...................... 51
  Private Sub DoFullExt() ................................................... 51
  Private Sub DoZoomIn(ByVal ext As MapObjects.Rectangle, pt As MapObjects.Point) ..................................................... 51
  Private Sub DoZoomOut(ByVal ext As MapObjects.Rectangle, pt As MapObjects.Point) ..................................................... 51
  Private Sub DoPan(ByVal ext As Rectangle, pt As MapObjects.Point) .................. 52
  Private Sub DoLayers(ByVal ext As MapObjects.Rectangle) .................. 52
  Private Sub Doidentify(ByVal ext As MapObjects.Rectangle, pt As MapObjects.Point, args As Object, vals As Object) .................. 52
  Private Sub DoQuery(ByVal ext As Rectangle, args As Object, vals As Object) .................. 52
  Private Sub AddHTML(ByVal ext As MapObjects.Rectangle) .................. 54
  Private Sub CreateError(ByVal message As String) ............................ 56
  Private Function CreateGIF(ByVal ext As MapObjects.Rectangle) As String .................. 56
  Private Function ExtractExtent(ByVal values As Object, arguments As Object) As MapObjects.Rectangle ..................................................... 56
  Private Function FindArgVal(ByVal str As String, args As Object, vals As Object) As String ..................................................... 57
  Private Function FindValArgs(ByVal str As String, args As Object, vals As Object) As String ..................................................... 57
  Private Function FindVal(ByVal str As String, vals As Object) As String .................. 57
  Private Function FindArg(ByVal str As String, args As Object) As Boolean .................. 58
ABSTRACT

The purpose of this project is to create a South Texas Interactive Nursing Geographic Information System (STINGIS) in support of the collaborative initiative Nursing Workforce: Beyond 2000 (NW2K). The coverage extends over the fifteen South Texas Greater Coastal Bend Region (GCBR) counties.

The STINGIS will provide the various workgroup members of the NW2K Consortium with access to geographically referenced information concerning the health risk of the population and the composition and capacity of nursing workforce demand in the GCBR over time. The project will provide the decision-makers with valuable spatial and temporal information through the World Wide Web.
BACKGROUND AND RATIONALE

This is an introduction to the South Texas Interactive Nursing Geographic Information System (STINGIS) project and why is it necessary.

The Nursing Workforce: Beyond 2000 (NW2K) is a project funded by the Robert Wood Johnson (RWJ) Foundation involving studies of the Greater Coastal Bend Region (GCBR) of South Texas. The GCBR encompasses an area of 13,891 square miles of brush country, agricultural lands and urban areas. Seven of the counties (Aransas, Calhoun, Kenedy, Kleberg, Nueces, Refugio and San Patricio) are located on the Gulf of Mexico. Population-wise, the region can be divided into two major groups of counties -- metropolitan and rural counties.

**Metropolitan**

- According to the U.S. Bureau of Census, three (Nueces, San Patricio and Victoria) out of the fifteen counties in the GCBR are considered metropolitan counties.

- Over 71% of the population in the region live in these three metropolitan counties that occupy less than 18% of the land, averaging slightly more than 174 people per square mile.

- The population growth for the 1990-1996 span was 9.3% for the metropolitan areas.
Rural

- The other twelve counties (Aransas, Bee, Brooks, Calhoun, Duval, Goliad, Jim Wells, Kenedy, Kleberg, Live Oak, McMullen and Refugio) are considered rural counties.
- Less than 29% of the population live in these twelve rural counties, that cover over 82% of the land, averaging just over 15 people per square mile.
- The population growth for the 1990-1996 span was 7.0% for the rural area.

The above facts reveal the GCBR of South Texas has a unique structure. The rural counties are sparsely populated, while the metropolitan areas have most of the nursing workforce of the region thus leaving the rural population drastically under-served with little or no health care at all. For 1997 year, the national average was 798 Registered Nurses (RNs) per 100,000 population, but in the GCBR, there were 532 employed RNs per 100,000 population. There were no RNs in Kenedy County according to the Texas Board of Nurse Examiners (BNE) Database. The population's health-risk profile is unique and very specific for the South Texas and may not be correlated to any other region in the U.S.

Four educational institutions in the region supply the nursing market with graduates of different levels. The programs offered by the schools of nursing in Bee County Community College, Del Mar College, Texas A&M University-Corpus Christi, and Victoria College vary significantly in the degree requirements. One of the priority tasks of the NW2K is to assess the current composition and capacity of the nursing workforce
by retrieving and analyzing nursing-workforce-profile information for the GCBR of South Texas.

The Health-Risk and the Nursing-Workforce profiles are the two major components that form the database foundation of this South Texas Interactive Nursing Geographic Information System (STINGIS). The project creates a Geographic Information System (GIS) that allows the authorized users to access the so-mentioned components through the World Wide Web. The STINGIS provides the client with an easy-to-understand spatial interface to the database information served through a Web Server extension on a selected port number. Thus, it will help the Nursing Workforce: Beyond 2000 Consortium and Workgroup members to collaborate more efficiently in making decisions important to the population health-care needs.
NARRATIVE

This is a description of the features of the South Texas Interactive Nursing Geographic Information System (STINGIS) project components. STINGIS is divided into server-side and client-side components. The server side portion of STINGIS consists of software written in Visual Basic using Map Objects components and is responsible for generating the maps and other features of STINGIS. The client-side portion of STINGIS consists of HTML and JavaScript pages generated by the server-side which can be displayed by a World Wide Web browser.

User Interface

STINGIS server functionality

For creation of the STINGIS server-side application, a simple graphical user interface (GUI) was implemented using MapObjects and MapObjects IMS classes (Figure 1).
Figure 1 - STINGIS server-side

STINGIS server-side has a map control located on the form. This memory-resident application serves the requests received by the Web Server on port 6666. Due to an error in the IMS components, at startup the STINGIS server cannot be minimized or programmatically made invisible. However, after startup and redraw of the full map the program window may be minimized on the server.

STINGIS client functionality

Shown below (Figure 2) is a view of STINGIS client-side in a Netscape web browser:
Figure 2 - HTML client-side

The user interface is grouped into two frames. The upper narrow frame handles help requests in form of square buttons. The frame below the help frame contains map extent, viewing-related command radio buttons, located atop the map extent, feature-related command radio buttons below the map control, layer visibility table and layer to be queried or identified to the left. For the user's convenience, STINGIS highlights the last command and selects that command's radio button as default.
The server-side application generates the HTML client code to be displayed by the client's web browser, and sends an image reference in response to client's request. The STINGIS HTML client has the following functions: Full Extent, Zoom In, Zoom Out, Pan, Layers, Identify, Query and Help. By selecting the desired radio button on the HTML form and consequently selecting the geographic feature of his/her choice, the end user can perform the basic functions of STNIGIS, namely Full Extent, Zoom In, Zoom Out, Pan, Layers, Query, and Identify. Full Extent and Help do not require selection of features. STINGIS recognizes the last selected command by locating the radio button selection and coloring the table data box around it. The above commands are deemed important to the STINGIS and briefly described below.

Full Extent

By selecting Full Extent, the user will “bring” the map extent into the web browser, spanning all the visible features in the layers collection. There is no need for the user to click on the map in order to select a position. The map will be displayed in full extent.

Zoom In

By selecting Zoom-In radio button, and a subsequent click on the map, the user will zoom in or “take a closer view”, i.e., will increase the viewable scale of the map.

Zoom Out

By selecting Zoom-Out radio button, and a subsequent click on the map, the user will zoom out or “take a more general view”, i.e., will decrease the viewable map scale by a constant factor, centered about the point selected on the map.
Pan

By selecting the Pan radio button, and a subsequent click on the map, the user will be able to pan (center) the map at the selected point.

Layers

The Layers section allows each layer to be toggled on and off by selecting the checkbox next to the layer’s name and clicking the Refresh Layers button. The server administrator can add layers in ArcView shapefile (*.shp) format at design time.

Identify

When Identify and a visible layer to be identified are selected, a subsequent click on the map a user will identify features at or near positions selected with the mouse. When Identify is active and the user picks a feature with the pointer, tables with the selected features’ attribute/value pairs will appear for the user’s further examination at the bottom. If the identifiable layer is a polygon, it will return only one feature. However, if the layer is a point, then the Identify command will return the features within 50 twips (roughly 2-3 pixels) of the clicked location (see Figure 3).
Figure 3 - Identify
Query

When Query and some visible layer to be queried are selected, the user may query by typing an ANSI SQL WHERE clause expression into the text area, followed by pressing the Query Layers button.

![Query Layers](image)

Figure 4 - Pre-Query view

Figure 4 shows STINGIS running with a single visible layer -- Tracts -- in the search from, and a search string of "females > males". In this instance, the selected spatial features from the Tracts layer attribute table are highlighted in yellow (shown on Figure
5). At the bottom, an equivalent to the issued *Query* command is shown as an ANSI SQL statement.

![Image of GIS interface](image.png)

**Figure 5 - Post-Query view**

*Remote map request*

A functional side-door is provided to allow an advanced remote user to implement his/her own interface and avoid the use of the existing STINGIS client-side interface (perhaps to add a custom map to another report, document, or HTML page). The details on how to accomplish this are given in the PROCEDURE,
Databases Used for STINGIS Implementation

Various databases exist at this moment of this thesis' writing. The tables and queries to access them are stored in Access-based database files (*.mdb) saved on various IBM PCs and UNIX machines. NW2K is an ongoing project (in its second three-year phase as of October 20, 1999). As part of this project, STINGIS is designed to supply the GCBR Consortium and various workgroup members with easy-to-understand, spatially represented, quantitative, thematic maps extracted from the above-mentioned databases. Various MS Access databases exist in the project's home account.

Texas State Data Center

The Texas State Demographer has various prediction models for the state population growth between 1990-2030. The different models are based on using different values for various statistically expected variables. The one used here is the most conservative, called the "1.00 scenario".

Reduced to GCBR 1990 Census

Approximately 2.5 GB of Texas-related demographic information, organized in dBASE tables, was downloaded from U.S. Census site via Network File System (NFS) protocol. Storage limitations required creating a reduced segment to only the fifteen county region database. At the time this paper was completed, the U.S. Bureau of Census has discontinued the NFS access and developed STF extracting software.
1997 Board of Nurse Examiners

This database was obtained from the Board of Nurse Examiners (BNE) in 1997 and is based on Mr. Kent Kerr's graduate project. The information is used to create the nursing workforce profile. In its full version the BNE database has some of the important nurse-registration attributes. For security reasons, the names and all the personal information has been removed for use in this project.

Conversion to shapefiles

From the three above-mentioned databases, the author created four ArcView GIS shapefiles (BNE97, ZIPs, Tracts, Counties). In turn the shapefiles, are used as themes to be represented, queried and selected from their features in the STINGIS. An ArcView shapefile is defined as a

"simple, non-topological format for storing the geometric location and attribute information of geographically referenced features. The shapefile format defines the geometry and attributes of geographically-referenced features in as many as five files with specific file extensions that should be stored in the same project workspace. They are:
* .shp - the file that stores the feature geometry.
* .shx - the file that stores the index of the feature geometry.
* .dbf - the dBase file that stores the attribute information of features.
When a shapefile is added as a theme to a view, this file is displayed as a feature table." ^2

The other two (*.sbn, and *.ain) files are spatial and attribute indexes respectively and are not pertinent for use in MapObjects applications. Any ArcView shapefile may be used in STINGIS.
ENVIROMENT

Minimum hardware requirements for reliable operation of STINGIS

Server-side

- IBM compatible PC (preferably Pentium 100 MHz or higher)
- 5 MB of available free disk space
- Permanent connection to the Internet/Intranet (preferably 10BaseT Ethernet network card or higher)

Client-side

- Connection to the Internet/Intranet via modem or network card;
- A computer with a monitor, regardless of the operating system

Minimum software requirements for reliable operation of STINGIS

Server-side

- Server-side STINGIS application
  (c:\ProgramFiles\ESRI\MOIMS\STINGIS\Stingis.exe)
- ESRI WebLink Dynamic-Link Library (c:\ProgramFiles\ESRI\MOIMS\weblink.ocx)
- ESRI MapObjects (c:\Program Files\ESRI\MapObjects\mo10.ocx)
- MS Visual Basic 5.0 Virtual Machine (c:\windows\system\msvbm50.dll)
• MS Internet Information Server
• ESRIMap extension to the Web Server (c:\root\www\script\esrimap.dll)

Client-side

• Frames enabled Web browser, preferably Netscape or Internet Explorer 3.0 or higher
• JavaScript enabled Web browser

Languages and Object components used

• MS Visual Basic 5.0 IDE\textsuperscript{10,12}
• ActiveX\textsuperscript{1}
• HTML 4\textsuperscript{13}
• JavaScript\textsuperscript{7}
• ESRI MapObjects 1.2\textsuperscript{2,3,5}
• ESRI MapObjects Internet Map Server 2.0\textsuperscript{4,8}
PROCEDURE

STINGIS is an Internet/Intranet Geographic Information System (GIS). STINGIS is developed utilizing the Internet mapping technology provided by Environmental Systems Research Institute (ESRI) MapObjects and MapObjects Internet Map Server (IMS) products. The interactive process of creating maps on the fly is shown as a three-tier architecture below (Figure 6).

![MapObjects IMS Diagram](image)

**Figure 6 – Map Objects IMS three-tier architecture**

The web browser is the main software component in the *Clients tier*. Other software components in the client tier are those that work in the browser and provide interactive capabilities (Java applets, ActiveX controls, Plug-ins). The *Web Server tier* consists of web server software. It administers requests and transmission of responses. When the web server receives a valid request to use a map application, it hands off the request to the map site administration service. The *Mapping Services tier* consists of a mapping
application. It receives a request from the server tier, processes the request and returns a response back to the server, which in turn transmits the response back to the client.

The following steps are conceptually important in order to implement the South Texas Interactive Nursing Geographic Information System.

1. **Acquire a server and install Windows NT 4.0**

A 128 MB RAM, 166 MHz Pentium IBM-compatible PC was acquired and designated as an Internet Map Server. The IMS PC is equipped with a 3Com 10-Base-T network card and was assigned an IP address on the cbi.tamucc.edu subnet. A Windows NT 4.0 Server license was obtained from a Windows NT distributor and was installed thereafter. The IMS PC was located at a secure place, the Conrad Blucher Institute (CBI) GIS Laboratory (referred to as a GIS Lab) in the Natural Resource Center, Suite 2108, 6300 Ocean Drive, Corpus Christi, Texas 78412, thus guaranteeing a non-interrupting service. After analyzing the purpose of the IMS and the services it is designed to run, the CBI network administrator assigned a static IP address (165.95.1.210) and entered its domain name as maps.cbi.tamucc.edu.

2. **Install Microsoft Internet Information Server**

Microsoft Internet Information Server (IIS) is a Web Server for use with Microsoft Windows NT operating system. The IIS has to be configured appropriately. For the purpose of this project, the IMS PC hosts both the Web Server and the STINGIS. In IIS, the web documents' root has been changed from c:\inetpub\wwwroot to c:\root\www\.
The STINGIS application has also been successfully tested on Windows9x using Personal Web Server (PWS).

3. Install ESRI MapObjects IMS extensions to the IIS

ESRIMap is a Dynamic-Link Library provided by ESRI that contains objects and methods that help the Web Server "understand" map requests from the client's Web Browser. The ESRIMap "listens" for map service requests, validates requests (existing services are defined in c:\root\www\scripts\esrimap.ini), and passes the request onto the Internet mapping application. MapObjects IMS provides a WebLink.DLL control that ensures the communication between the ESRIMap extension to the Web Server and the server-side STINGIS application. WebLink.DLL has two important properties:

- LocalIP as String -- Returns or sets the local IP address to which the WebLink binds
- MapPort as String -- Returns or sets the TCP/IP socket address on which this link will listen.

WebLink also has eight methods: Start, Stop, WriteResponseHeader, WriteFile, WriteString, BMP2JPG, BMP2GIF, and EnableGIF, two of which are shown below:

- Start As Boolean -- starts listening for requests on a specified port, such as the following:

```vbnet
Private Sub Form_Load()
    If Not WebLink.Start Then Unload Me
End Sub
```
Stop -- suspends listening and terminates any established connections, such as the following:

```vbs
Private Sub Form_Unload(Cancel As Integer)
    WebLink.Stop
End Sub
```

Since STINGIS is a Web-enabled mapping program, it has the WebLink control present.

In the Visual Basic environment, WebLink may be placed anywhere on the Visual Basic form, because it is an invisible control.

4. Convert Source Data for use in STINGIS

Four shapefiles were created to demonstrate STINGIS functionality. Excerpts from the four shapefiles' attribute tables along with brief descriptions are enclosed below:

4.1. BNE97 (7 records shown)

The Board of Nurse Examiners 1997 data was geocoded with accuracy greater than 95% address or ZIP centroid matching (Figure 7). The last three fields, Longitude, Latitude, Census_id, were added as a result of the geocoding. For security reasons, the registration number and mailing address were the only fields used from each registered nurse record. Upon request, the remaining personal information could be joined to the BNE97 shapefile using the attribute Primary (RN#).
4.2. ZIPs (8 records)

Coverage of the United States Postal Service 5-digit polygons was obtained from a freely distributed geographic data CD. To the existing shapefile, I added the field Rn_100kpop, which represents a number of nurses per 100,000 people (Figure 8). The field was added in ArcView using Pop97 prediction and BNE97 data. The formula for creating the field was Rn_100kpop := RN_ZIP * 100000 / Pop97, where RN_ZIP was the count of RNs in each given ZIP code as provided by the BNE97.

4.3. Tracts (2 records):

Census Tract is a similar measure to the USPS 5-digit ZIP code area. While the tracts are not as well-known to the general public as the ZIP codes, they provide a wealth of information such as the Census Population and Housing statistics. This shapefile was
reduced to about 20% of the available Population and Housing STF-3A information
(Figure 9). Should the need arise to add more information, Fips can be used as a key to
join the additional attribute information.

```
150, 73179, 4846901603, 48, 469, 48469, 001603, 4709, 6029, 31, 2, 1535, 2327, 2382, 4369, 14
3, 36, 9, 152, 687, 464, 1165, 644, 1836, 385, 215, 548, 2437, 27, 101, 187, 79, 121, 783, 413, 8, 6
6, 1769, 234, 1187, 348, 75900, 466, 1363, 48, 12, 106, 134, 0, 95
110, 18300, 4846901501, 48, 469, 48469, 001501, 2147, 1938, 19, 5, 731, 1094, 1053, 2038, 21,
6, 7, 75, 319, 156, 514, 282, 714, 288, 193, 228, 1111, 20, 69, 129, 61, 46, 305, 236, 10, 36, 795, 6
4, 633, 98, 61800, 294, 597, 2, 0, 1, 0, 0, 183
```

**Figure 9 – Census tracts attribute table excerpt (2 records)**

4.4. **Counties (2 records)**

The four Compact Disks containing the Census 1990 demographic information were
mounted via NFS from the computer database of the U.S. Census Bureau. The
demographic information was subsequently copied to the local file system, and filtered to
extract the 15 county region out of the 254 Texas counties. This was done to reduce the
data and save disk space and processing time. The 1990 Census Summary Tape Files 3A
(STF-3A) provide a variety of demographic information. A 170 population-related
questions and 92 housing-related questions comprise the database files. A county-level
demographic resolution necessary for this project, can be satisfied most of the time
(Figure 10). Census STF-3A files contain data at tract- and block-group level. A
shapefile joining the geographic and the demographic attribute tables uses a common
key, such as Federal Information Processing Standard (FIPS) 3-digit county code. The
data is located on the map server in c:\ESRI\esridata\USA\Texas\xv\. The GCBR
county FIPS codes are given in Figure 11:


Bex, Texas, 48, 025, 48025, 880.3911, 25135, 27954, 29, 8592, 12433, 12702, 19443, 727, 103, 2, 31, 4631, 12909, 2189, 5736, 4833, 6445, 3070, 2862, 4179, 10932, 492, 1495, 1323, 798, 1070, 2, 912, 2240, 175, 723, 10208, 1616, 5480, 3112, 39400, 233, 7267, 198, 275, 764, 244, 0, 1285, 743, 648, 142710, 26477

Figure 10 - Counties attribute table excerpt (2 records)

```
<table>
<thead>
<tr>
<th>FIPS</th>
<th>COUNTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>Arkansas</td>
</tr>
<tr>
<td>117</td>
<td>Texas</td>
</tr>
<tr>
<td>424</td>
<td>Bex</td>
</tr>
<tr>
<td>057</td>
<td>Coke</td>
</tr>
<tr>
<td>131</td>
<td>Crook</td>
</tr>
<tr>
<td>175</td>
<td>Culb</td>
</tr>
<tr>
<td>249</td>
<td>Dall</td>
</tr>
<tr>
<td>361</td>
<td>Erath</td>
</tr>
<tr>
<td>273</td>
<td>Erath</td>
</tr>
<tr>
<td>297</td>
<td>Jack</td>
</tr>
<tr>
<td>311</td>
<td>Llano</td>
</tr>
<tr>
<td>355</td>
<td>Lamp</td>
</tr>
<tr>
<td>391</td>
<td>Llano</td>
</tr>
<tr>
<td>409</td>
<td>Panhandle</td>
</tr>
<tr>
<td>409</td>
<td>Parmer</td>
</tr>
<tr>
<td>469</td>
<td>Victoria</td>
</tr>
</tbody>
</table>
```

Figure 11 - The fifteen GCBR counties

A shapefile is added statically to the Map control in Visual Basic. A right-click on the
Map control followed by selecting Properties brings up the property form (Figure 12).
Figure 12 - Adding a shapefile

For simplicity, addition of shapefiles to the Map control is allowed only at design time.

Run-time shapefile addition was not implemented in STINGIS.

5. Build the client-side HTML application

This project allows an end user to interact with STINGIS’ server-side application through the Internet/Intranet using a web browser. The server-side application generates the HTML for the client-side application to be interpreted in the remote-user's browser software. The browser window is divided into two frames, menu and map. Listed below is the HTML code of the /STINGIS/index.html:

```html
<html>
<head>
<meta name="author" content="nikolay toodorov">
<title>Welcome to South Texas Interactive Nursing GIS</title>
</head>

<frameset rows="70,*" border=0>
  <frame name="menu" scrolling="no" noresize target="map" src="menu.html">
  <frame name="map" scrolling="yes" src="map.html">
  <noframes>
```
The use of frames in this case serves a double purpose. The first reduces the traffic from the server to the client, and the second hides the internal STINGIS commands passed in the URL as a form method=get.

Listed below is HTML code of the /STINGIS/map.html

```html
<html>
<head>
<title>Checking the Map server availability...</title>
</head>
<body background="/STINGIS/images/toptxtr.gif">
The code performs a client-pull of the STINGIS. If STINGIS is not running on the server, esrimap.dll responds with an error message “Map Server is not available”.

The AddHTML(ext As MapObjects.Rectangle) procedure produces the following sample HTML code as a result of the execution of the server-side mapping application:

```html
<tr td>
<input type=checkbox name=lyr value=Nurses checked=Nurses (Point)>
</td>
<tr td>
<input type=checkbox name=lyr value=ZIPs checked=ZIPs (Polygon)>
</td>
<tr td>
<input type=checkbox name=lyr value=Tracts checked=Tracts (Polygon)>
</td>
<tr td>
<input type=checkbox name=lyr value=Counties checked=Counties (Polygon)>
</td>
```
There is an important issue regarding the uniqueness of the image map transaction to each client. In case of multiple requests to the same mapping service, it is of utmost importance to return to each client exactly what he/she requested. This is handled by returning an unique image file name. As in the above example 030927_1.gif, which is composed of the hhmmsst formatted time stamp of the request (3:09:27) and the request counter for this client (_#, i.e. this was response to request #1 from the map server).

The geographic area of importance to this project lays in the area bound by the westernmost Longitude of -100° (in the HTML form as Left), and the southernmost Latitude of 26° (in the form as Bottom), and the easternmost Longitude of -95° (in the
form as Right), and the northernmost Latitude of 30° (in the form as Top). By
convention, negative longitudes indicate West of Greenwich locations and can be
converted in absolute longitudes by adding 360°. When the user selects the desired radio
button on the form (say Pan) and clicks on the image pixel (say x=33 and y=50), the
HTML form requests the following URL:

http://maps.cbi.tamu.edu/scripts/esrimap.dll?name=STINGIS&Cmd=Pan&
Left=-100&Bottom=26&Right=-95&Top=30&click.x=33&click.y=50

This request is handled by the esrimap.dll and transferred to the STINGIS server-side
mapping application. The HTML documents are stored locally on the map server
c:\root\www\STINGIS\ or through the Internet at http://maps.cbi.tamu.edu/STINGIS/.

6. Build the server-side mapping application

The server-side mapping application is the core component of STINGIS and is specific
for the health-care delivery system in South Texas. It has been built using MapObjects,
MapObjects Internet Map Server, and WebLink libraries.

6.1. Cartographic organization of a map

An abstract map can be represented as a set of transparent layers overlaid on top of each
other (Figure 13). This indeed is the cartographic approach.
Figure 13 - Map organization (cartographer's view)

The different color features are separated on mylars and prepared for preprint one by one.

From the programmer's point of view, a map can be thought of as a map control object (Figure 14).
Figure 14 - Map display objects (programmer's view)

The geographic, socioeconomic, and demographic features of a map can be singled out as *layer objects*. This way the information the layer carries is easily manageable. A layer object may be a raster image (raster images are not used in STINGIS) or of one of the three fundamental vector-types: *point, arc, or polygon*. A set of layers composes the *layer collection*. A *tracking layer* is a special kind of map layer that does not require the layers collection to be refreshed with changes in its contents. It is useful for placing non-feature-related graphics, or plotting dynamic data, such as real-time position of moving satellites, vessels, or vehicles. Due to the lack of such activity on this project, the
tracking layer was mainly used to draw selected by Identify or Query RNs data. This guarantees that if RNs are selected, then the corresponding points are displayed on the top of the polygon layers in red color.

6.2. Orientation and coordinate systems

Most mapping applications have to make certain assumptions about the display of spatial data. The problem of representing parts of the Earth’s surface greater than 20 km in length (or areas greater than 400 km²) is as old as the Earth. It is impossible to “flatten” the Earth’s assumed shape, spheroid or ellipsoid, to a planar mapping surface without “sacrificing” the distance, the area, or the angular conformity. This project covers an area of about 250 km by 280 km. For practical purposes, an insignificantly small-biased assumption is made that an arc second of latitude is equal to an arc second of longitude for these latitudes (1” ~ 31 m). Thus scaling correction is not necessary. The geographic coordinates are taken directly from the ArcView shapefile as decimal degrees. Visual Basic uses TWIPS pixel values (1440 TWIPS = 1 inch). A conversion between TWIPS and geographic coordinates can be performed by one of the Map control methods:

- ToMapPoint(x as Single, y as Single) as Point;
- FromMapPoint(point as Point, x as Single, y as Single).

6.3. Object organization

The server-side mapping application can be extremely sophisticated. That is, it may have a variety of tools, organized in pull-down menus, buttons, or forms. Nevertheless, if there is no interface written for the client-side application, STINGIS becomes useless.