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Contributing Authors:
Shi Chen, Carolyn Fish, Allison Hurley, Peter Kloehn, Kerry Kramer, Gregory Kuleba, Matthew Leech, William Melville, Jacqueline Schuler, Edward Sheehe, Tyler Stoner, Zachary Tardivo.

Contacts:
Greg Kuleba: gwk123@psu.edu
The Pennsylvania State University, Undergraduate in Geography (GIS)

Allison Hurley: arh5041@psu.edu
The Pennsylvania State University, Undergraduate in Geography (GIS)

Comments:

This Design Document acknowledged and agreed to by:

Date:
Design Specifications Document

Introduction

Project Description
In an effort to allow for a fair election between all candidates, including incumbents, we will draw new boundaries for the districts of Pennsylvania. 2000 Census data, as well as other important data from Pennsylvania, will be manipulated using mapping software to arrive at a newly configured map displaying the redistricted state of Pennsylvania. Each district will have approximately equal population. The lines will be drawn in such a way that county, school district, and other municipal boundaries are taken into account in the formation of districts with high geographical cohesion. Geophysical boundaries created by mountains, rivers, or large water bodies will also be taken into consideration during the redistricting process as well. For example a large river that currently divides a single district may serve as a boundary for two separate, newly created districts.

Objectives

Data Collection
The first objective is to gather the necessary data that is needed to draw new boundaries. This includes census data, current legislative districts, school districts, municipalities, counties, roads, and hydrography. This data will be taken from the Pennsylvania Spatial Data Access (PASDA)\(^1\). Once this data is collected, it will be joined together so that analysis can be carried out. For example, census data will be joined with census tracts.

Data Analysis and Initial Redesign
The data will analyzed by the ESRI\(^2\) ArcGIS\(^3\) extension “Districting.” This software will construct districts based purely on the number of districts desired and the population desired in each district.

District Redesign
Using the newly constructed districts, we will manually change the shape of the each district in order to comply with the project requirements. This will include overlaying the school district, municipality, county, hydrography, and roads layers on top of the newly constructed districts. After the initial district lines have been edited, the final district boundary maps will be completed.

Printed Map/Web Application
A printed version of the final maps will be made for the client. A website will be constructed in order to showcase the final redistricted maps to the public. The website will be built using HTML web programming language.

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\(^1\) Pennsylvania Spatial Data Access (PASDA) is Pennsylvania's official public access geospatial information clearinghouse. [http://www.pasda.psu.edu/about/default.asp](http://www.pasda.psu.edu/about/default.asp)

\(^2\) ESRI designs and develops the world's leading geographic information system (GIS) technology; including ArcGIS. [http://www.esri.com/about_esri.html](http://www.esri.com/about_esri.html)

\(^3\) ArcGIS is a complete system for authoring, serving, and using geographic information. It is an integrated collection of GIS software products for building and deploying a complete GIS wherever it is needed—on desktops, servers, or custom applications; over the Web; or in the field. [http://www.esri.com/software/arcgis/index.html](http://www.esri.com/software/arcgis/index.html)
Overview

Our final product will consist of three parts:

- A website accessible to the public (url yet to be determined)
- A set of detailed descriptions regarding the procedures implemented to achieve a new redistricting
- A printed version of the redistricted map of Pennsylvania. The website will include the current map of the districts in Pennsylvania as well as a map of the possible redistricted state.

Along with the two maps that will serve as a comparison, interested viewers will also be able to access the statistics (in the form of graphs or tables) used to create the new boundaries. The print-out version will be a large redistricted map of Pennsylvania which The Honorable Eich may use for outreach and education, decision making with his colleagues, or as he sees fit.
Data Design

The project data will be stored in a locally available Personal Geodatabase called ‘PA Redistrict’. A Geodatabase is a database that is used for storing, accessing, and managing spatial data. This Geodatabase holds the Census Block Group shapefile called ‘BlockGroup_Join’ joined with the ‘Summary File1’ data table, based on the STFID field which exists in both attribute tables. The districting extension will give the user an option to select whether to use the BlockGroups with the summary file joined or not joined (Figure 2). For this project, it was decided to use the BlockGroup_Join because the data would be easier to access because it would remain all in the same place. The only true advantage over combining the table to the geography would be to reduce the initial runtime of creating the Districting Plan. The basemap data was also all saved locally on a Geography department drive.

The ‘BlockGroup_Join’ and Summary Data file were collected from the ESRI website[^3]. This information is freely available to users. The remaining data used for the project is listed in the Table 1, and was collected as the base map from the Pennsylvania Spatial Data Access (PASDA)[^4]. Specifically for the US House Districts Data, the user must select the ‘All Data’ button from the bottom of the search page. From there one can navigate to the ‘Boundaries’ group on the left hand side under the ‘Filter by Category’ and select the ‘title’ listed below in the spreadsheet (Figure 1).

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[^3]: The ESRI website can be accessed through this url: [http://arcdata.esri.com/data/tiger2000/tiger_download.cfm].

[^4]: The PASDA website can be accessed through: [http://www.pasda.psu.edu/uci/SearchPage.aspx]
### Summary of Data

<table>
<thead>
<tr>
<th>Data Type</th>
<th>PASDA Website Category</th>
<th>Title</th>
<th>Originator</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>School Districts</td>
<td>Boundaries</td>
<td>Pennsylvania school districts</td>
<td>Pennsylvania Department of Transportation</td>
<td>2007</td>
</tr>
<tr>
<td>US House Districts in PA</td>
<td>Boundaries</td>
<td>Pennsylvania congressional boundaries (Act 34)</td>
<td>Pennsylvania Department of Transportation</td>
<td>2007</td>
</tr>
<tr>
<td>PA State House Districts</td>
<td>Boundaries</td>
<td>Pennsylvania state house district boundaries</td>
<td>Pennsylvania Department of Transportation</td>
<td>2007</td>
</tr>
<tr>
<td>PA State Senate Districts</td>
<td>Boundaries</td>
<td>Pennsylvania state senatorial boundaries</td>
<td>Pennsylvania Department of Transportation</td>
<td>2007</td>
</tr>
<tr>
<td>PA Municipality Boundaries</td>
<td>Boundaries</td>
<td>Pennsylvania municipality boundaries</td>
<td>Pennsylvania Department of Transportation</td>
<td>2007</td>
</tr>
<tr>
<td>PA State Roads</td>
<td>Transportation</td>
<td>Pennsylvania state roads</td>
<td>Pennsylvania Department of Transportation</td>
<td>2007</td>
</tr>
<tr>
<td>PA DEM</td>
<td>Elevation</td>
<td>Pennsylvania Digital Elevation Model -30 Meter</td>
<td>USGS</td>
<td>1996</td>
</tr>
</tbody>
</table>

**Table 1.** The table above shows the summary of the data used in the PA redistricting project.
Figure 2. Data from the 2000 Census (PA_Blocktable) was joined to a topological data layer (PA_Blocks) in order to create shapefiles that contain corresponding Census data.
**Map 1.** Pennsylvania Block Groups overlaid on a Digital Elevation Model displaying topographic relief for PA.
Map 2. Map showing the current school districts statewide.

Map 3. Map showing the current PA House Districts (203 districts).
Map 4. Map showing the current US House Districts (19 districts in PA).

Map 5. Map showing the current PA Senate Districts (50 districts).
Map 6. Map showing the current PA House districts, the current US House Districts, and the current PA Senate Districts.
Functional Design

Legal Limitations
The problem at hand is a difficult one; one that does not have “correct” answers. Although the Undergraduate Redistricting Team is dedicated to creating new, unbiased, districts for the state of Pennsylvania using our geographic expertise and useful data we have collected; the team acknowledges the fact that even by attempting to remain as unbiased as possible some bias may/will inevitably reside within the new districts. This is simply the result of the complexity of the issue and the many factors we are both taking into consideration and those which we are not.

We have decided to use topography, hydrography, and school districts to help us determine where to place new district boundaries. To exclude bias we are not using voter registration/party affiliation data in our redistricting. However we realize that such factors are not always the best criteria on which to base our decisions. Therefore we have also resorted to researching the demographics of specific areas (mainly large cities). This will hopefully allow us to avoid segregating groups of individuals within the same economic status/ethnicity/etc. For example, if we only based our decisions on the physical land features we may inadvertently group a majority of one demographic in a single district.

However, knowledge about areas comes with tradeoffs which mean that as we become more informed about the demographics of an area it becomes easier to subconsciously include bias into our redistricting process. Also some people may conclude our final design is biased as viewpoints will differ between individuals. Although there may not be a correct answer to this problem, our answer will be supported with notes detailing our reasoning behind our decisions throughout the redistricting process.

Software Limitations
The criteria for creating unbiased districts are difficult to define in GIS. The existing system tends to ignore school districts, travel barriers, county lines, and political lines. To include these criteria in district creation is a difficult process. The use of the ESRI extension is limited in District generation by how computer intensive the generation process is. From test generations this process can last for more than 18 hours to complete.

Data Limitations
Our goal is to make the most accurate and detailed boundaries for our districts. Although we have moved from census blocks which are the smallest deviation of census boundary lines, the transfer to census block groups congeals well with alternate boundaries like municipalities, school districts and previous political districts. There is very little limitation in the data we have access to and are using, our problem will not be obtaining the correct data, but manipulating it to produce unbiased district boundary lines.

Proposed Approaches

Overriding Principles
While examining each of these processes, the project constraint criteria of school districts, counties, hydrography, transportation lines, and land features will be overlaid while modifying districts.
This will reduce the time spent modifying each district. The chance of then modifying a district twice, once without the criteria and again with the criteria, is then eliminated.

**Top Down**
This method will start with the creation of the 19 US House Congressional Districts. Each of these Districts will be sub-divided into the 50 State Senate Districts in order to maintain regional identity. These State Senate Districts will then be divided into the 203 State House Districts.

**Bottom Up**
To create this district plan, the 203 State House Districts will be generated first. These complete districts will be joined to create the 50 State Senate Districts. From these 50 Districts the 19 US House Congressional Districts will be constructed.

**Unique**
This approach will create 3 complete unique District Plans for each of the 3 Legislative Districts. The Districting Extension will draw boundaries for each based solely on the total of number of districts and population desired for each district.

**Final Selection**
The final approach used will be determined by the ability to conform to the given parameters while maintaining a reasonable timeframe for project completion.
Interface Design

Map Design

The following map (Figure 3) is a template for the final six maps that will be included in both the printed poster and the website.

![Map of Pennsylvania Senate Districts 2007](image)

**Figure 3.** Map displaying the template for the design and layout of the redistricted maps. Specifically, this map shows the current PA Senate Districts.

The map above shows the current Pennsylvania Senate Districts in the format they are expected to be shown on the final layout. This map will be a part of a six part thematic map series which will display the current and proposed boundaries of the Pennsylvania Senate Districts, Pennsylvania House Districts, and United States House Districts. The consistencies across the six thematic maps will include: the same colors, layout, font, and inset maps.

**Assignment of Colors For Each District**

The colors were randomly assigned for each district and then were adjusted so that no adjacent...
districts had the same color. This was all done by adding a ‘color’ field in the attribute table and labeling with either ‘brown’, ‘orange’, ‘blue’, ‘purple’, or ‘green’. In the ‘properties’ for the layer under the symbology tab, under ‘categories’ in the ‘show’ window, unique values were added under the new field of ‘color’. Each of the colors were then assigned according to the follow specifications:

**Application of Buffered Gradient**

A buffered gradient was added by going into the symbol selector dialog box and selecting ‘properties’. Under the drop down menu for type, gradient fill was selected. The style was defined as ‘buffered’. The intervals were defined as 35 and the percent was 20.

**Colors (in RGB for website display; in CMYK for printed display)**

In order to define the colors for each, right click on the color ramp and select ‘properties’.

- **Blue** Buffered Gradient:
  
<table>
<thead>
<tr>
<th>Color 1</th>
<th>Color 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red- 115</td>
<td>Red: 227</td>
</tr>
<tr>
<td>Green- 155</td>
<td>Green- 155</td>
</tr>
<tr>
<td>Blue- 186</td>
<td>Blue- 186</td>
</tr>
</tbody>
</table>

- **Green** Buffered Gradient:
  
<table>
<thead>
<tr>
<th>Color 1</th>
<th>Color 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red- 137</td>
<td>Red: 225</td>
</tr>
<tr>
<td>Green- 173</td>
<td>Green- 227</td>
</tr>
<tr>
<td>Blue- 128</td>
<td>Blue- 225</td>
</tr>
</tbody>
</table>

- **Orange** Buffered Gradient:
  
<table>
<thead>
<tr>
<th>Color 1</th>
<th>Color 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red- 219</td>
<td>Red: 255</td>
</tr>
<tr>
<td>Green- 177</td>
<td>Green- 247</td>
</tr>
<tr>
<td>Blue- 118</td>
<td>Blue- 235</td>
</tr>
</tbody>
</table>

- **Purple** Buffered Gradient:
  
<table>
<thead>
<tr>
<th>Color 1</th>
<th>Color 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red- 185</td>
<td>Red: 240</td>
</tr>
<tr>
<td>Green- 159</td>
<td>Green- 235</td>
</tr>
<tr>
<td>Blue- 194</td>
<td>Blue- 242</td>
</tr>
</tbody>
</table>

- **Brown** Buffered Gradient
  
<table>
<thead>
<tr>
<th>Color 1</th>
<th>Color 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red- 212</td>
<td>Red: 252</td>
</tr>
<tr>
<td>Green- 195</td>
<td>Green- 249</td>
</tr>
<tr>
<td>Blue- 165</td>
<td>Blue- 235</td>
</tr>
</tbody>
</table>

**Map Layout**

The layout is custom and includes two inset maps one of Philadelphia and one of the Pittsburgh area both of which have many districts and thus it is hard to discern where districts start and end. The maps are all in Albers Equal Area with a central meridian of -77.6. The box containing the two inset maps
is filled with 10% grey. The large amount of room in the grey box allows for notes to be added at the end of the project containing date created, creator, and other important information.

**Fonts**

Black Arial was used for all of the fonts to keep the map looking simple. The main title is in point size 24 and the “Philadelphia” and “Pittsburgh” titles for the insets used point size 12 and the “Philadelphia” and “Pittsburgh” titles inside the main map are in point size 8.

**Inset Maps**

Each of the six maps will have the same geographic scale for each of the inset so that the maps look nice in series.

**Template Maps Layout Design**

Below is the template design for the six maps (Figure 4). This will be the design used on the print map. This design was created in ArcMap with a buffered gradient background with intervals of 220 and a percentage of 75.

![Template Map Design](image)

**Figure 4.** Template for the overall design of the poster.

<table>
<thead>
<tr>
<th>Background</th>
<th>Color 1:</th>
<th>Color 2:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>Red: 191</td>
<td>Red: 0</td>
</tr>
<tr>
<td></td>
<td>Green: 210</td>
<td>Green: 111</td>
</tr>
<tr>
<td></td>
<td>Blue: 255</td>
<td>Blue: 255</td>
</tr>
</tbody>
</table>
Website

The website is the venue used to allow public access to the redistricted maps. It will be hosted on Penn State web space and posted by the Redistricting Team. The overall layout of the site will be in 3 frames with side button navigation. Convenience, ease of use, interactivity, and professional appealing design layout are the key goals of the site. The structure of the site has already been coded by the team and will only require ‘tweaking’ once the final map(s) are designed and posted on the site. There will be descriptions of the design document, a description of the problem, steps and methods used to derive the final output, the design (cartography) of the map, analysis and comparison of the new map versus the current map, helpful links to other information about redistricting, and finally information about the redistricting team and how to contact us/the geography department.

Homepage

Figure 5. Template for the design of the website, with a url yet to be determined.
The website, logo, header, and buttons are all original and designed by The Redistricting Team. Other pages that have been designed are the Problem, Results, and Links pages. They have been supplemented with text, pictures, and data to show the general design, purpose and layout of that particular page.

Results Page

Here is the design layout of the Results page (Figure 6):

![Figure 6](image)

Penn State Undergraduate Redistricting Website, Results Page as of 1-Nov-07
Property of the PSU Geography Undergraduate Redistricting Team 2007

Figure 6. Template for the design of the website, with a url yet to be determined.

The page has been filled with an example ArcMap to allow the cartography designers to see how much space is available and how colors used in the software appear on the web. This will be the most important page of the website because it shows our results. The next most important page will be the analysis where the validity and accuracy of the redistricting map is argued against the current map. Any weaknesses, inaccuracies, or flaws in the map will also be mentioned on this page to show that no map is entirely accurate.
**Documentation, Credits, and About Us**

Finally, the Documentation, Credits, and About Us pages will be the extra information about the team so the public can better understand who the students were that redistricted Pennsylvania. The Documentation page will list the steps and ideas we progressed through over the 10 or so weeks from inception to implementation. It will have progression for the overall project as well as the steps each separate team (such as data and cartography teams) took to complete a part of the project on time. The Credits page will give credit to each individual person and their contributions towards the project. This is to show who put in individual expertise in each separate area. The About Us page will give a biography of the class and the diverse majors, influences, expertise and interests that played a part in working on the project.
Corrections

As progress continues on the project we have realized better our limitations. The website that will be part of our final output will still include a visual representation of the redistricted state and the corresponding statistics for all three legislative boundaries (PA House, PA Senate, US House) being mapped. The maps will not be dynamic but rather be static maps with the option to click radio buttons which will launch a new window with the corresponding layer included in the map. In this way a user will have the ability to “interact” with the map while not having true dynamic maps.

Along with this the group has decided that it still may not be possible to create maps projecting the future composition of the entire state of PA. The impacts on the number of women who would be elected, the effect on minority representation, and whether or not the state would be ‘redder’ or ‘bluer’ is component that at this time will not be included in the final product(s). Selected projections may be made using voter registration data for selected areas in PA. These areas would likely include heavily populated areas such as Philadelphia and Pittsburgh. Statistics for these areas would then be displayed with the corresponding map.
Conclusion

It is impossible to draw non-partisan legislative district boundaries when redistricting is in the hand of incumbent political leaders. The problem surrounding the restoration of the “one person, one vote” principle can be solved by placing the task of redistricting in the hands of this non-partisan group of students. We have the necessary resources and are committed to delivering a usable product. Our expertise is applicable to this issue and comes without cost to the client.
Sources
