

## **Strategic Assignment of Public Safety Personnel Using GIS**

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### **Abstract**

A presentation of analysis toward defining improved police districts that reflect a more balanced distribution of **workload** from what is known about the demands from incidents, complaints, and other responsibilities on the officers. A few approaches are examined for this project done for the New Castle County Police Department (Delaware) that examined distribution of incidents, average travel time, priority, on-scene workload, and other factors.

**Workload** – the amount of time the total number of officers are spending on-scene at any one particular incident.

### **Introduction**

The New Castle County (NCC) Police Department is located in New Castle County, DE (southwest of Philadelphia and northeast of Baltimore). They are responsible for servicing the entire county, including many municipalities (Arden, Ardencroft, Ardentown, Bellefonte, Middletown, Odessa and Townsend), with the exception being those municipalities that have their own police departments (Elsmere, New Castle City, Newark, Newport and Wilmington). Delaware City is a unique case where the county only services the city at certain times of day (overnight and weekends). The population occupying the entire service area is 385, 817 with the remainder of the population, 114,448 (including Delaware City), in the cities and towns that have their own police departments. These numbers put

together form the 500,265 people that make up the population for New Castle County, DE, according to the 2000 United State Bureau of the Census.

The total number of incidents for the county during the time period of the study (January 1, 2001 – January 29, 2003) is 270,071. Of those total incidents, 255,978 could be mapped using a combination of geocoding services, the Geographic Data Technology road file as well as the road centerline file from the New Castle County Department of Land Use. The incidents that were not mapped were part II crimes with insufficient street addresses from the incident reports of the officers and were not considered essential to the study according to the NCC Police Dept.

Currently the service area for the NCC Police Dept. is divided into four districts, three above the C&D Canal (Districts 1, 2, and 3) and one below (District 4). Each of the districts is then divided into four sectors (1,2,3,4), with the name of the district prior to the sector number to form the full sector name (i.e. Sector 11– District 1/Sector 1). The Southern Patrol Unit division services **District 4** below the Canal (**IGNORED FOR THIS PROJECT**) and the NCC Police Headquarters services the other three districts above the canal. A total number of officers on patrol at any one time typically consist of between 25-30 officers. However, they are not divided evenly among the four districts. District 4 consists of 4 officers, two inside the Town of Middletown and two outside the town. District 1 also has a smaller percentage of officers as well, typically 5-6. The rest of the officers are divided amongst Districts 2 and 3.

This variation in the distribution of officers amongst the different districts accounts for differences in the workload (time spent on-scene) of the officers. For instance, an officer in District 2 could be responding to 10 calls per shift while an officer in District 1 could responding to 5. Also the severity of the crimes occurring in Districts 2 and 3 seem to be greater than Districts 1 and 4. Both of these circumstances as well as others could create hostility amongst the officers, burn out of the officers and provide a higher potential risk for some officers over others.

The Center for Applied Demography and Survey Research was asked to modify the current district and sector boundaries as well as provide a fresh look into new sectors and districts to better balance the workload of the officers. The modified version of the current districts was accomplished with the help of the redistricting extension inside of Arcview 3.1 as well as ArcInfo Workstation 8.x and the fresh look was completed with algorithms used within the Arcinfo Workstation 8.x network commands.

## **Criteria for Determining the Modified and New Sectors/Districts**

This section discusses briefly the various considerations taken into account for redistricting.

### *Number of Incidents*

The number of incidents occurring in each district provides a first look at the overall spatial distribution. The total number of calls for service from January 1, 2001 – January 29, 2003 was geocoded by the crime analysis unit of the New Castle County Police (does not contain all calls for service) and locations could be mapped and the number of incidents per district totaled. Viewing activity just from the number of incidents showed an imbalance among the existing districts.

### *Priority and Severity of Incidents*

The type of incidents occurring in an area and the priorities associated with them are an important consideration in addition to the actual numbers of calls for service. For instance, ten burglaries have a different impact on the community than do ten residential alarm calls. In this project incident priorities were in line with New Castle County police incident priority classifications, and incidents within a district were not only viewed in terms of numbers but also by incident priority.

### *Work Load*

Workload was quantified as the estimated time that officers on the street would spend at an incident. Some incidents are much more demanding than others. A burglary in progress could use up to 5 officers and take much more time to handle, where a residential alarm in many cases involves only one responding officer and can be resolved in a short time. Much of the data screening in this project was involved in examining incident records to determine the expected time and personnel needed for various types of incidents.

### *Response Time*

An examination of district delineations requires some idea of the time it takes officers to respond to an incident. Where the balance of the number of incidents or workloads are the primary consideration, this can lead to the delineation of large districts for areas of low density, as with Southern New Castle County. While demands might be lower, response times would be greater. Knowledge of the transportation infrastructure is crucial in determining this time as well.

### *Available Personnel*

The average number of officers available on the streets per shift would set a practical limit to the number of districts and sectors that the county could be

divided into. For this project a number of 25-30 officers was assumed to be available for fieldwork as defined by squad rosters.

### Support Backup

The availability of public safety personnel from the municipalities, State, or other jurisdictions for emergency backup is a consideration. For instance, if only one or two officers are available in Southern New Castle County, the State Police from Troop 9 can provide support. Municipalities such as Newark, Elsmere, Wilmington, New Castle and Delaware City have their own police departments and have had communication with the county in the past.

### Existing Arrangements

Arrangements that have been set up with the county Police Department with the Town of Middletown and Delaware City need to be taken into consideration. However, with district 4 having a strategic plan in place below the canal already, the Town of Middletown's arrangement can be ignored in our evaluation of the sectors/districts.

## **Data Used for Project**

### Arcview Shapefile of Calls for Service from 1/1/01 until 1/29/03

- This file provides us the spatial location of the incident.

### RMS Database– Records Management System Database

- This database provides us with the initial call type and the final case types of the incident. Call types allow us to define the priority of the call that comes into the dispatcher. Case types provide us with the final call types that are reported on the officer's paper report.

### MIS Database – Management Information System Database

- Incident Database - The incident database provides us with the final call type and the received, entered, dispatched, in route, on scene and clear dates and times entered by the dispatcher. For this particular project, we will be using the on scene and clear dates and times.
- Unit Database – The unit database provides us with the unit\_id and the dispatch, on scene and clear dates and times for each officer responding to an incident.

Priority Code List – List of incident code descriptions and priorities whose codes are related to the initial call types and case types from the RMS and the final call types from the MIS.

New Castle County 2000 Census Blocks – Demographic area that is used in conjunction with the redistricting extension in Arcview to create the modified version for the sectors and districts. Incident locations are aggregated to this demographic area along with all of the attributes from the incidents.

Modified Grids (State of Delaware demographic region). Modified Grids were used for the creation of the new sectors and districts as well as a visual tool for the comparison of the current, modified and new sectors and districts. Incident locations are aggregated to this demographic area along with all of the attributes from the incidents.

DelDOT Centerline File – Road centerline file from the Department of Transportation that was used for the creation of the new sectors. Connectivity and attributes allowed for the file to be turned into a spatial road network.

Sector/District Shapefile – Original shapefile from the New Castle County Police Department that was used as the current sector and district boundaries. Municipalities within the county that have their own police departments are omitted.

## **Processing the Data**

Processing of the data had to occur before the modified and new sector/district delineations could be achieved. This relates back to the old adage that good results, in our case, good boundaries, can only be achieved with good data. For this project, CADSR had to scrutinize the data as well as find out the manner in which the source data was created. Knowing how the data was created, by whom and how the different databases relate to one another, allows us ask questions and make sound decisions as we process the data. The processing of the data occurred in a number of steps:

- 1) Convert Arcview shapefiles from their respective years, 2001, 2002 and 2003, into ArcInfo coverages. Combine coverages into one complete incident coverage (data layer) for the whole county.
- 2) Join RMS database to the incident data layer by case\_no. This allows the original call\_type and case\_type, if applicable, to be brought onto the attributes for each particular incident.
- 3) Relate the incident code priority list to the incident data layer and calculate the priorities for each incident within the layer. Used later for comparison between current, modified and new sectors/districts only.
- 4) Convert Unit Database into SPSS file. Time is converted into seconds. Subtract clear time minus on scene time to get the actual on scene time for each officer. If the clear and on scene dates do not agree (on scene date is one

day later), we add 86,400 seconds to the clear time and subtract. Any on scene times greater than 12 hours are deleted.

- 5) Perform frequency on Unit database based on unit\_ids. This gives us the unit\_id for officers on the streets, sergeants, detectives and any other officers that might be reporting to an incident. Delete all records that do not pertain to officers on the streets.
- 6) Perform frequency on unique identifier (concatenation of inc\_no & case\_no) of Unit database and sum the clos\_tm (clear minus on scene time). This provides us with the total amount of time all officers spent at that particular incident. The frequency provides us also with the number of officers that arrived on scene. Officers that did not have on scene times were not used.
- 7) Relate on scene times from Unit database to Incident database if there is more than one officer reporting on scene to that particular incident. This will override the on scene time from the Incident database with more accurate values.
- 8) Perform descriptive statistics on final call type (call\_case) in incident database in order to obtain median values.
- 9) Join on scene times with the original complete incident data layer. If the incidents do not relate, then the median value is used.
- 10) Aggregate the point incident data layer and all its attributes up to census blocks and modified grids (demographic area used in the state of DE).

These previous steps provide us with an incident data layer that has accurate on scene times.

### **Modified Version of Sectors and Districts**

The modified version of the sectors and districts was accomplished through the use of the Redistricting 3.1b extension inside of Arcview. Its original purpose was to redistrict the political districts after the 2000 Census. However, many organizations have used it to realign school districts and police districts, like we have done in this case. The concept for the extension is pretty easy to understand. You have a total number of people, kids, incidents or workload organized as a point or polygon shapefile and you have a total number of desired sectors or districts. If you divide the total number of people, for example, by the total number of districts, you can come up with an average for the number of people for each district. The average is then used as a reference point for the process of determining the districts. Finally you can then begin selecting the point or polygons, calculate their district and ask the computer to determine if that district is below or above the reference point. Depending on the percentage above or below the reference will determine if you have to add or subtract more points or polygons in that particular district.

The modified police sectors were determined with the workload value (on-scene time of the total officers) aggregated up to the census block level (polygon

shapefile). Our reference point or ideal value for each district was 15.8 on-scene hour per day (189.6 total on-scene hours per day / 12 sectors). We started out on the eastern portion of New Castle County, with the boundary of Wilmington on the south and the Delaware River on the east. Using local knowledge of the transportation network, we began selecting block polygons from the east and continued until we reached I-95 on the west. With the western boundary set, we continued northward selecting more blocks until we came as close to our reference number as possible (15.7 OSHrs/Day). Our second sector started out with the first sector on the south, the Delaware River on the east and the PA border on the north. With these constraints and a major arterial running west, we began selecting blocks in an east-west direction. We finished the sector when we reached a major arterial on west and our total on-scene hours per day were .8 below the ideal. All of the other sectors were created in the same fashion as the two above using numerous criteria to determine the shapes and sizes of the sectors.

The main determining factor for the creations of the sectors were the total on-scene hours per day. However, as described in the criteria section of the paper, this was not the only factor. Other include the length of the response times that will be created due to size of the sector, the knowledge of the transportation infrastructure for backup support, the jurisdictional boundaries that are present within the county and the severity of the crimes within each sector created. All of these factors provide the user of the extension (creator of the sectors) with some support for the reasoning behind his or her modified version of the sectors.

### **New Version of Sectors and Districts**

The process for determining the best, or 'optimal', location for the center of the sector so that the service is accessible to the population in the most efficient manner is called location-allocation. This is the process we used for the new version of sectors for the New Castle County police. The goal in our case is to provide the optimal locations for the twelve sectors based on the demand from incidents from the past two years or so, while still minimizing the total distance traveled by constraining it to ten miles. This model within the process that we used is called the MINDISTANCE (constrained) model, according to ArcInfo.

The  $P$ , number of facilities that will be located, for our project was limited to the number of districts desired by the New Castle County Police, twelve. The demand for the officers was the workload value (on-scene time) as described earlier. This demand was aggregated to a demographic polygon area known as a modified grid for the county. The centroids of the modified grids along with the workload values were then associated with nodes in the road network. The road network was created from a Delaware Department of Transportation coverage and the total distances traveled for the network were calculated with input from the distance of

the segments and the speed limit of the segment. With the demands from the incidents on the network, the mindistance model was implemented providing us with the optimal locations for the centers of the new sectors. Sector boundaries around these centers were then created using the outlines of the grids along with their defined centers, the original sector boundaries, major roads and neighborhood outlines.

## **Conclusion**

Having created both the modified and new sectors, we can compare these statistically to the current sectors. We can look at the total hours per day, the percentage of priorities within each sector, the current and estimated population and also the average and maximum times and distances. These statistics show us that we can come close to balancing the workload, but at what cost is this to response times and distance traveled. These are the decisions that the New Castle County Police are going to have to make. They are going to have to decide what is a priority to them, providing equal coverage to all of the population or being able to respond to the higher priority incidents in a timely fashion. These are tough decisions that are going to have to be made, but the geographic information system is the tool to provide them with the statistics for their decisions.