GIS for Missing Persons

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Introduction

Geographic information systems (GIS) supports businesses by providing a spatial component to the decision making process. When implemented successfully, GIS can prove to be a powerful tool for management, operations, and advocacy. In a business landscape, these tools may afford companies a competitive advantage over their spatially challenged competitors. However, in the non-profit sector, these tools may offer something much more than a competitive advantage; GIS can save lives. This was made apparent after a personal tragedy affected the way I viewed geospatial tools. A system that I mainly understood in a business context, suddenly took on a whole different purpose and implementation translated into a new level of urgency. The current paper will outline a proposed not-for-profit business that will provide vital geospatial services to families in search of missing persons. This business model is based off personal experience that I will detail as a case study in the following section. The business model will follow a traditional approach for designing spatial systems and include five phases of development: planning, analysis, design, implementation, and maintenance.

Case Study: Missing Persons

On November 9th, 2012, a mass email was distributed from a close friend detailing the circumstances surrounding the missing person report that was recently filed for her older brother, Richard. Many people who were familiar with Richard would describe him as a gracious and amorous individual that was trusting to a fault. Richard was born with a mild disability which delayed his mental development. However, these challenges did not prevent him from seeking independence. With the assistance of a local non-profit, Richard was successfully living his first year out of his parent's house in his own apartment, worked full time at a local large-chain box store, obtained a driver's license and maintain a flawless driving record.

On Monday, November 5th, Richard left his work close to midnight and walked alone to his car through a dark and empty parking lot: this was the last time he was seen by his friends. Richard's family made an official missing persons report on Wednesday, November 7th and began contacting close family and friends to determine his whereabouts. Unbeknownst to the family, the police department was not involved in search efforts beyond a traditional investigation and had little advice on how to initiate a public search campaign. By the morning of Friday, November 9th, the mass email was distributed to hundreds of contacts pleading for

help in distributing flyers, searching for clues, and spreading the word about the efforts to others. Although many people were willing to step forward to help with the search, most people were unsure of where to start. Richard lived and worked in the San Francisco Bay Area, an area covering roughly 6,984 square miles and home to approximately 7 million people. During these initial efforts, volunteers reported having problems downloading and printing the flyers, determining areas to best focus their efforts, and displaying flyers in areas that were already covered by another person. During missing person cases when time is working against the missing, this fragmented search effort can be futile and perilous. After just a few hours, it was clear that a more coordinated effort was needed.

With the aid of various social media platforms, Richard's family was able to rally over 50 volunteers in a coordinated effort scheduled for Saturday, November 10th. Volunteers would comb the Bay Area in search for Richard's car, distribute flyers, and talk to local residents and business owners in hope for leads. In preparation, the family contacted a friend with GIS skills to organize the operation that was set to begin less than 24 hours.

Considering the large size of the Bay Area, it was immediately apparent that we need to focus on smaller search area. According to recent bank records, Richard's ATM card was last used on Tuesday, November 6th in Oakland, California. Since this was the last solid lead, it was decided that search efforts would center on this area (figure 1). With a focused search area determined, a new problem arose: volunteer safety. Oakland, California is ranked the fourth most dangerous city in the United States with an average of 26.3 murders and 1,683 violent crimes per 100,000 people. After speaking with a local police officer, it was apparent that we needed to warn the volunteers of the potential dangers and provide them with a detailed map highlighting the areas which to avoid or take special precautions.

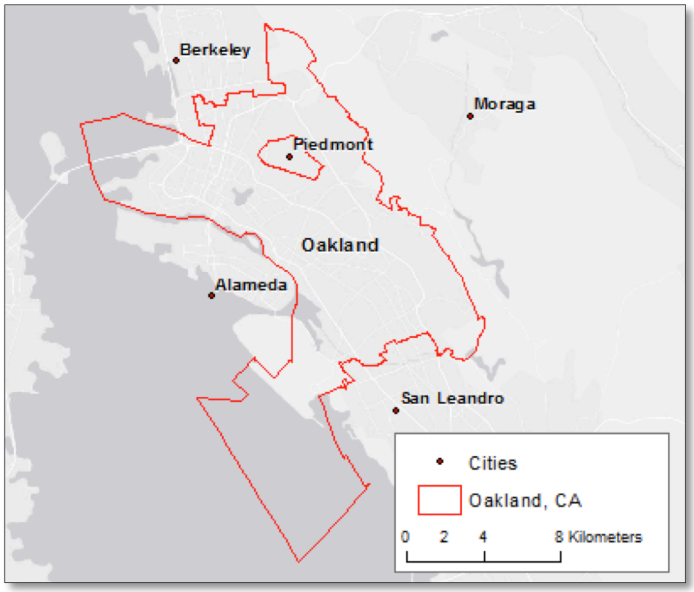
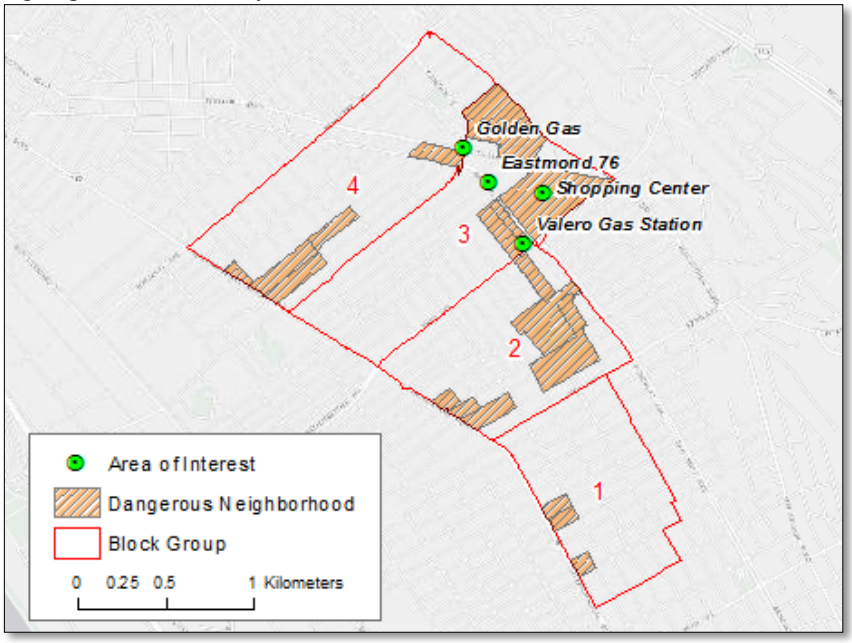


Figure 1. Area of Oakland, CA as displayed on ArcMap 10 desktop

ArcMap 10 desktop was utilized to create custom search maps with several layers of relevant data. Each volunteer group received a detailed map containing search areas designated by several continuous block groups. Maps were customized and included layers for crime, shopping centers, gas stations, parks, and other areas of interest (see figure 2 for example).

Figure 2. Example of custom search area created by continuous block groups with several layers of information



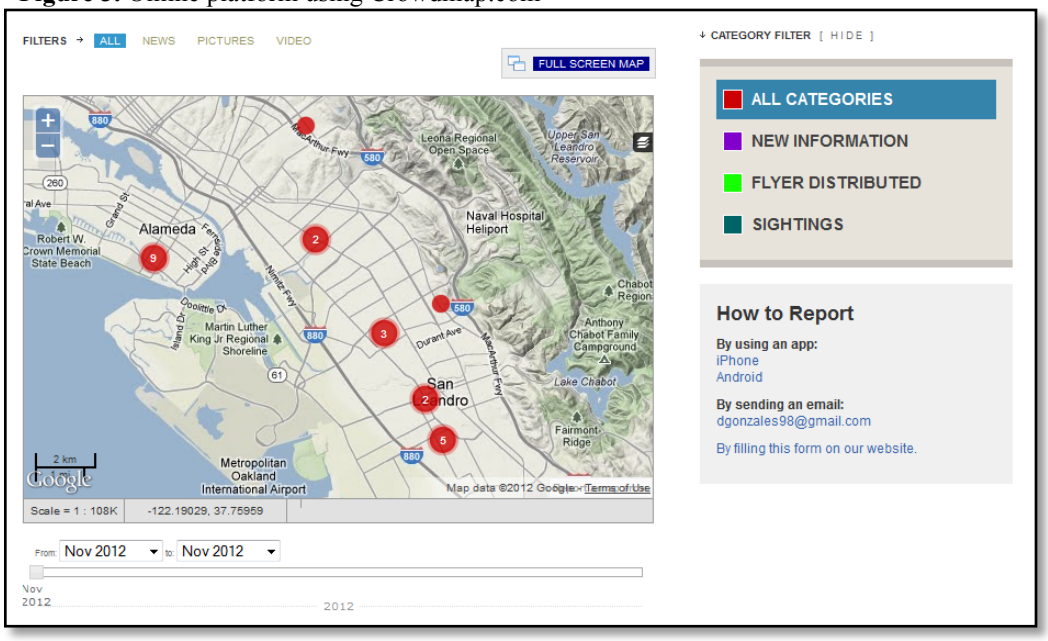
Spatial data was retrieved from several different sources. Data and sources included in the maps are detailed in table 1 below:

Table 1. Information about data used in the missing persons map. Includes a list of the data used including name, description of the data, and source.

Data Name	Description	Source	File Type
Area of Interest	Layer containing list of local gas stations, grocery stores, shopping centers, and other establishments that were identified as important to the search effort	Google Earth	KMZ
Block Group	Smallest geographical unit used by the U.S. Census Bureau for published sample data	U.S. Census (2000)	Shapefile
City Outline	City outline obtained from school district information from the U.S. Census Bureau	U.S. Census (2000)	Shapefile
Dangerous Neighborhood	Oakland's 100 most dangerous neighborhoods according to homicide and shooting numbers for 2011	ArcGIS Online	Shapefile

For the mobile component, each volunteer group downloaded the Ushahidi.com application to their smart phone to track their location and efforts. Ushahidi is a non-profit tech company that specializes in developing free and open source software for information collection, visualization, and interactive mapping. Crowdmap is an Ushahidi tool that allows users to crowdsource information from a mobile phone and view their data on a map in real time without having to know the intricacies of running a server. For the current project, this mobile crowdsourcing application provided a platform for volunteers to update their status and provide any new information (i.e. leads, sightings, location of flyers distributed) while in the field. An example of the Crowdmap platform can be seen in figure 3 (below).

Figure 3. Online platform using Crowdmap.com



Lessons Learned and Moving Forward

On Saturday, November 10th, all volunteers were successfully dispatched to their appropriate search areas where they safely distributed flyers and obtained several leads. Richard's car was located less than one mile from the location that his credit card was last used in one of the volunteer's search areas. Unfortunately, Richard was not safely reunited with his family, however, as a result of the extensive search efforts, his body was recovered.

In the process of this ordeal, several important discoveries were made. First, in 2011, the FBI reported 678,860 missing person cases in the United States alone; approximately 1,860

reports every day (FBI, 2011). The gravity of this statistic became apparent after other families in similar situations reached out through several social networking platforms to help in the search process. Second, there were no clear tools or instructions for looking for missing persons that we were able to find on the web. In the time of crisis, it is difficult to navigate through all the different opinions and suggestions and without a clear approach; a successfully implemented coordinated effort may be at risk for failure. The next sections of this paper will outline the five phases of systems development for the proposed not-for-profit geographic information service to aid in the search for missing persons.

The Five Phases of Systems Development for GIS

As a result of the recent experience, we have decided to create a not-for-profit business that provides users with a tool to organize a search for missing persons. This not-for-profit business, called *Mapping for Missing Persons*, will be accessible via the Internet with the mobile crowdsourcing capabilities. Users will be able to utilize this easy-to-use service for free and will have access to several data layers that are specific to locating missing persons during a search effort. This next section will describe the phases necessary when planning the development and integration of the new not-for-profit *Mapping for Missing Persons*.

In the book, Geo-Business: GIS in the Digital Organization, Pick (2008) provides five steps for designing and developing spatial systems (Pick, 2008). Pick notes that GIS can be better planned if the process is divided into steps. The book details the steps as applied to a preexisting business that requires management "buy-in" and support. However, the following steps will be used to detail the development of *Mapping for Missing Persons*, a GIS system for a new not-for-profit service to aid in the search process for missing persons. Therefore, when referencing Pick's five phases, we will make slight modifications to fit the current proposed system.

Phase I: Planning

The first phase, planning, involves conceptualizing the system, broad planning, and justifying the need for a GIS. This phase also includes budgeting, staffing, scheduling, and overall feasibility of the plan. The case study outlined earlier in the paper forced us to conceptualize and plan a system that could be utilized only by experienced GIS users. However,

for our target population, we need to plan for an easy-to-use spatial mapping system that can provide accurate data, be deployed within minutes, and used by non-experienced GIS users during a time of high stress. An essential element in the system is the combination of online and mobile components. The amalgamation of these two components will allow users to track volunteers' efforts and ensure areas are thoroughly searched.

Phase II: Analysis

The second phase, analysis, includes information gathering, discovery, visiting and hearing the users' needs, and developing and prioritizing spatial system requirements. This phase ends with a proposal for full design and implementation. Information may be gathered from diverse sources including consultants, companies that are not direct competitors, industry, vendor literature and websites that provide spatial services. The resulting prototype will be tested and reviewed by potential users and will show where there are weaknesses in the project.

In the case study, we described the integration of several data layers that were specific to our needs. After extensive consideration, we realize that, depending on the unique situation and location of each user and search area, additional data layers may be necessary. Data considered for the project in this phase will include, but will not be limited to, the following:

1. Esri basemaps
2. General crime statistics, location of past crimes, and neighborhoods with high crime rates
3. Local business information
4. Location of all traffic cameras
5. Location of all police stations
6. Location and information of all parks and abandoned lots
7. Location and information of all registered sex offenders
8. Demographic information from US Census including state, city, school districts, block group, and zip code boundaries

The target population for the current project may be difficult to access which may cause some problems during the analysis phase. However, focus groups comprised of parents, law enforcement, or friends and family of missing persons may be used to help gather information on

potential users' needs. These focus groups will help identity the overall needs for the system and clarify all information (including data) that must be collected prior to the design and implementation phase.

Phase III: Design

The third phase, design, includes diagramming, researching, and specifying of the fine points of the prospective system, *Mapping for Missing Persons*. Tasks in this phase combine GIS, IS, and business knowledge and skills. The potential users are consulted extensively during this phase to include all necessary detail into the final design.

After the planning and the analysis phase, we will be ready to build an easy-to-use website that is able to connect to various APIs. With the assistance from key consultants identified from our focus groups, the design will incorporate many of the elements essential for a successful and coordinated search effort. These elements may include applications that incorporate Facebook, Twitter, and other various third party applications to increase exposure to the missing person. The website will be accessible on mobile devices including both Android and IoS. In this phase, the applications will be tested extensively to ensure accuracy and user compatibility. These mobile applications will be able to access important updates and simultaneously be able to upload new information including but not limited to the following:

1. Location of posted flyer(s)
2. Upload information (i.e. sighting, leads, etc) that can be labels as urgent, questionable, or private
3. And other information as needed

As a final step in this phase, we will look for funding and skilled volunteers prior to the implementation phase. This may be accomplished through several avenues that are beyond the scope of the current project.

Phase IV: Implementation

In the fourth phase, implementation, the application is built based on the specifications of created in the design phase. The system can be either built in-house or outsourced. All necessary data will be loaded into the databases, data warehouse, or directly into tables in the GIS.

For the current project, the data that was found to be highly important to the search efforts for missing people will be collected and uploaded into the data warehouse. All data layers will be accessible for free on both desktop and mobile devices to all who register for our services. Data that updates more than once a month (i.e. crime data), will be accessed through a web feed to stay current. If necessary, we will rent our own cloud to store data and maps that are being used and accessed by site users. Once this phase is complete, all necessary staff will be hired and trained appropriately.

Phase V: Maintenance

The fifth and final phase, maintenance, occurs when the system is in use but continues to need support correcting bugs. In this phase, additional features can be added that were not included in the original design. The maintenance phase may last for several years allowing for continue training and support to the users.

For the current project, *Mapping for Missing Persons*, the final phase will focus on maintaining the website, servers, and API connections. The system will be updated to include suggested tools and functionalities as necessary.

Conclusion

While the *Mapping for Missing Persons* site plan is not completely inline with the original scope of the class assignment we feel that this project has great potential to-do good in the world. Through lessons learned first hand we strongly feel that this is a product that will be used by people in desperate need of free easy-to-use tools to help them find those they love. We look forward to taking what we have learned and learning from others to create a GIS application to bring visual order to a chaotic ordeal.

References

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