

# Visualizing Opportunities: GIS Skills for Retail Marketing

Peter Y. Wu

wu@rmu.edu

Dept of Computer & Information Systems,  
Robert Morris University  
Pittsburgh, Pennsylvania 15108, USA

Eugene Rathswohl

gener@sandiego.edu

School of Business Administration,  
University of San Diego  
San Diego, California 92110, USA

## Abstract

Business students need to develop skills in the intelligent use of information, especially spatial information, for decision-making. Geographic Information System (GIS) is a viable tool for that purpose. Yet the few GIS courses in the Information Systems curriculum offered in various business schools tend to focus on different concepts and skills. In this paper, we examine the application of GIS in retail marketing. With access to appropriate data, GIS is an excellent tool for the analysis and identification of market opportunities. We describe a skill set of three specific approaches in GIS application using demographics data pertaining to potential customers and collected competitors' information. These approaches include visualization using choropleth maps, spatial overlay to classify feature information based on spatial correlation, and proximity analysis for site selection. These techniques allow us to identify where the potential customers are located, study competitor locations, and analyze opportunities for site selection. By identifying these techniques in the GIS skill set, we also discuss the pre-requisite knowledge for the students and what we may or may not emphasize in the design of GIS courses in the IS curriculum.

**Keywords:** GIS, geographic information system, retail marketing, visualization, spatial overlay, proximity analysis.

## 1. INTRODUCTION

Fueled by much lower costs and easier access to data, geographic information system (GIS) is becoming more widespread in the IS/IT market place (Gewin, 2004; Sinton & Lund, 2007). GIS is useful in a wide range of application areas ranging from traditional logistics planning to political campaigning, health care, environmental studies, community development, retail marketing, and more. The past decade has seen a healthy growth of GIS courses in

academia to prepare students for the need in industry. However, the growing body of knowledge pertaining to the use of GIS has led to different courses in different business schools having widely different emphases (Glover, 2005; Reames, 2005). This paper focuses on the GIS skills pertaining to the use of GIS in retail marketing. Our intention is to discuss the appropriate content of a GIS course focusing on business as an area of interest in the IS curriculum.

In the section 2, we describe and discuss the GIS skills we have identified as useful in retail marketing. In sections 3, 4 and 5 we discuss the use of GIS in the context of application examples, starting with simple information visualization (North, Fee & Bytnar, 2009) and then more advanced techniques of applying spatial overlay and proximity analysis. The three GIS techniques comprise the basic skill set for using spatial information in retail marketing. In section 6, we discuss what this means to us in the design of GIS courses in the IS curriculum with a business focus. Section 7 presents the summary of our paper.

**2. GIS FOR RETAIL MARKETING**

A major focus of retail marketing is on the potential customers: Who are our best customers? What do they buy? Where they are located? Where are similar customers located? How can we better serve them? Given the right data, GIS is an excellent tool for answering those questions. To identify the opportunities there, we need to analyze the information about the people and to visualize where they may be located. We need the relevant demographics information and the appropriate maps. Maps are costly to make, but for most community mapping in the United States, these maps are publicly available on the internet. Large collections of demographics information are also published by the U.S. Census Bureau on their web sites. The information is updated every decade in accordance with census. Table 1 and table 2 below present the web sites from which we obtained the maps and the demographics information for use in this paper.

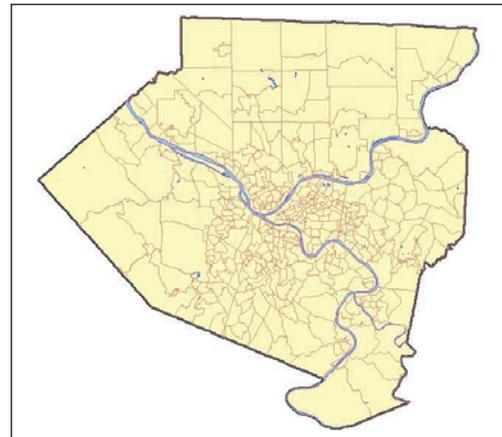
<b>Web site for maps (by ESRI)</b>
<a href="http://arcdata.esri.com/data/tiger2000/tiger_download.cfm">http://arcdata.esri.com/data/tiger2000/tiger_download.cfm</a>

**Table 1.** Source of Maps

<b>Web sites for Census Data</b>
<a href="http://www.census.gov">http://www.census.gov</a>
<a href="http://factfinder.census.gov">http://factfinder.census.gov</a>

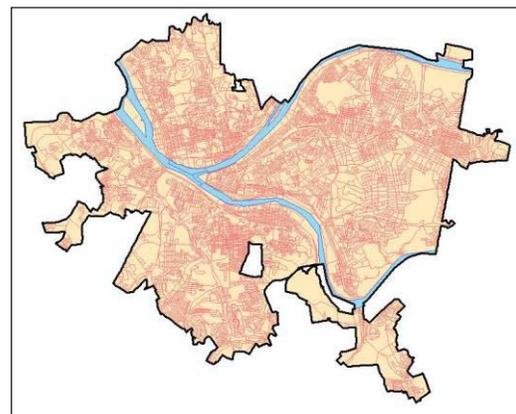
**Table 2.** Source for Demographics Data

While keeping individual private information confidential, the US Census Bureau publishes census information in various aggregations. Figure 1 shows the map of 416 census tracts in Allegheny County in the state of Pennsylvania.



**Figure 1.** Census tracts in Allegheny County

While each county is subdivided into census tracts, each census tract is further subdivided into census blocks. The smallest unit is the census block for which aggregate information is published. Figure 2 illustrates the map of census blocks in the city of Pittsburgh.



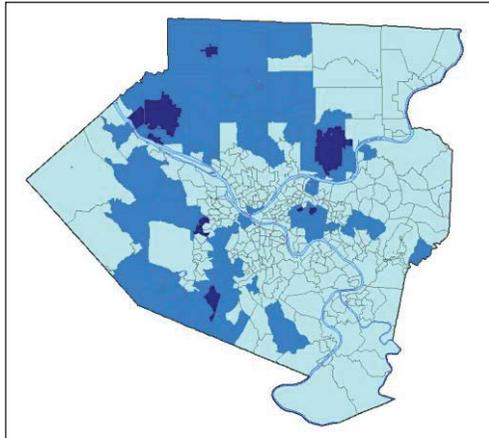
**Figure 2.** Census blocks of Pittsburgh

Using demographics information from the Census Bureau, we can then utilize GIS to learn where our potential customers are located. The following sections describe three different approaches to identify marketing opportunities using GIS.

**3. INFORMATION VISUALIZATION**

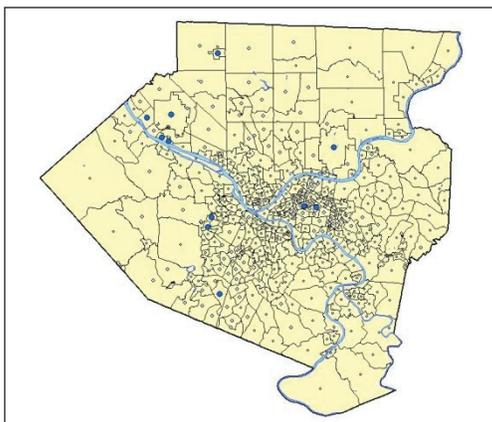
Depending on what we plan to sell in retail business, we may want to identify people at a certain income level as our target customers. Since the average per capita personal income is published in the aggregate information for each census tract, we can choose various income levels to shade the regions in graduated colors, in order to visualize how income varies across a

geographic area. Figure 3, an example of a choropleth map, illustrates the census tracts of Allegheny County, shaded in light, medium, and dark blue for per capita annual income levels respectively at 25,000 or less, 25,000 to 50,000, and above 50,000 (in US dollars).



**Figure 3.** Per capita income by census tract

However, we should note that tracts of larger areas show up in the map prominently do not necessarily indicate more population. Rather, census tracts are chosen so that they have roughly the same population. Instead, we use a pin map with graduated size marker at the centroid of each tract. The marker may also use graduated colors to indicate the different average income levels. Figure 4 is the pin map based on the same data as in figure 3, but it uses a marker at the centroid of each tract. The different colors and sizes of each marker indicate the per capita annual income levels in the tract.

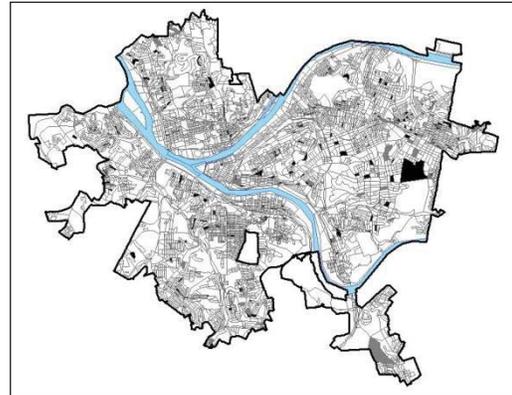


**Figure 4.** Per capita income using markers

By choosing different intervals of per capita income level, we can use GIS to conveniently

visualize the location of the higher income neighborhoods. If we can gather the data for different years, we may also visualize the changing patterns in a sequence of maps.

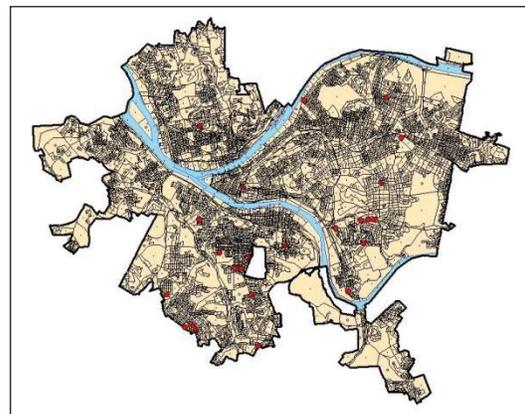
We may target a specific ethnic group in marketing. Suppose we want to promote a certain product to the Hispanic population. Figure 5 is a map to illustrate the Hispanic population by the census blocks in the city of Pittsburgh.



**Figure 5.** Hispanic population by census block

The Census Bureau publishes the population information of every major ethnic group at the census block level. The shading scale of black, grey, and white indicates the Hispanic population of each census block, respectively at 10 or less, 11 to 20, and more than 20.

There is also population information per age group at the census block level. Suppose we want to find where the elderly population is in order to target senior citizens of age 65 or older. Figure 6 uses a graduated size marker at the centroid of each census block in the city of Pittsburgh.



**Figure 6.** Senior population by census block

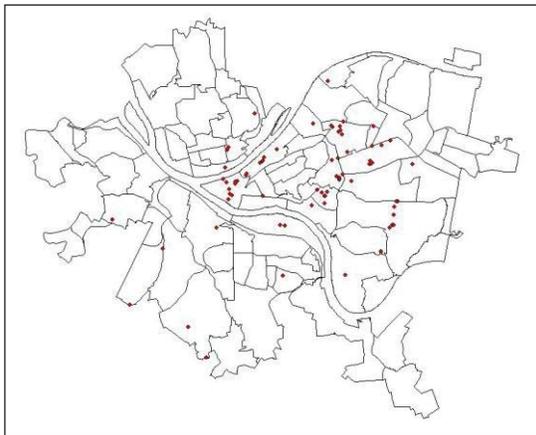
The markers indicate the senior (65 or older) population in each census block: small light blue marker for 10 or less, medium beige marker for 11 to 30, and big red marker for above 30.

#### 4. SPATIAL OVERLAY

The administrative regions of our business may not coincide with the census tracts, or with the census blocks. The information we need also may not be readily available, or associated with our administrative regions.

For example, we may want to examine where our business competitors are located, by the municipalities in the city. Given the physical addresses of competitor locations, we apply geocoding to create a point feature layer of the locations in a map. Geocoding is the process of converting coded information such as postal address into a map location. It is often one of the featured functions in GIS. (Wu & Rathswohl, 2010)

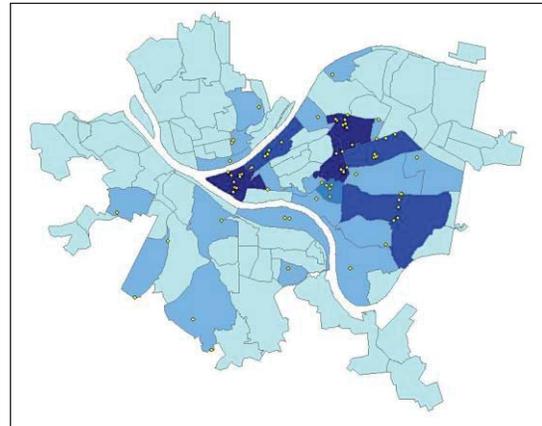
Figure 7 presents a map showing the locations of the competitors, indicated with markers in the municipalities in the city of Pittsburgh. Note that the point markers are maintained in a separate map layer in the GIS. This means that the information pertaining to each competitor is associated with the point feature as marked, but not with the municipality in which it is contained.



**Figure 7.** Competitor locations in the city

To associate each point with the municipality containing the point, we need to apply spatial overlay, or spatial join. With spatial overlay, each municipality will be associated with the marker points contained in the region. With spatial join, we add an attribute value to each point location to recognize its containing municipality. After the overlay operation, we can easily count the number of competitors

within each municipality. Figure 8 illustrates a map using graduated shading to indicate the number of competitor locations in each municipality.



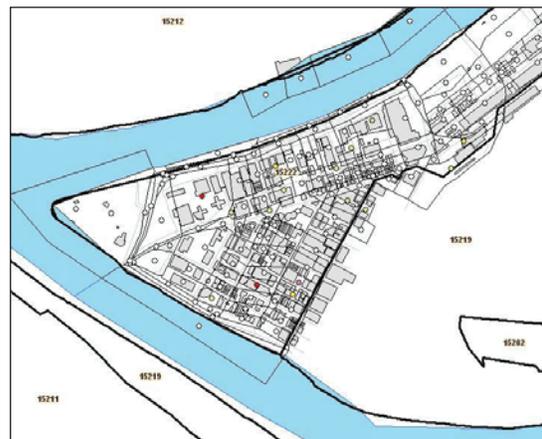
**Figure 8.** Graduated shading after overlay

The shading scale has five shades of blue to indicate the number of competitor locations. The class intervals are: 0, 1-2, 3-5, 6-8, and 9-10 stores in the municipality, respectively.

GIS generally offers many map processing operations. We have chosen spatial overlay as an indicative example to illustrate how GIS does the computation of spatial correlation in map data processing.

#### 5. PROXIMITY ANALYSIS

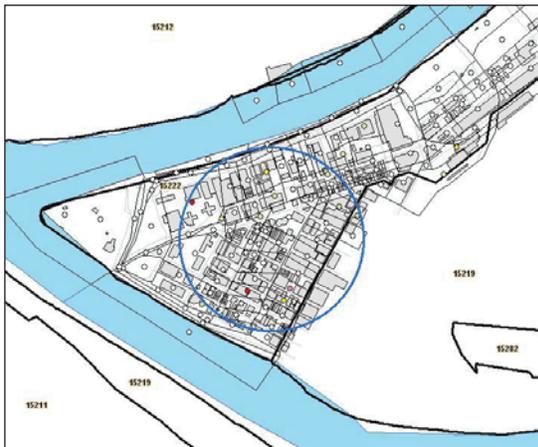
Another aspect of spatial correlation is the question about the vicinity. GIS can help us answer the question using proximity analysis. It applies to retail marketing, for example, when we plan to select an appropriate site for a store.



**Figure 9.** Population details in downtown area

We want to have potential customers within certain proximity to the location. Figure 9 shows a map of the Central Business District in the city of Pittsburgh, with detail information about the population per census block, within the zip code areas of Pittsburgh downtown, the Central Business District.

Suppose we want to find a desirable site for a grocery store in downtown area. Even with the tax credit incentive to promote residence in the downtown area, there are mostly commercial buildings. The census data gives us the population of residents per block. We want to identify suitable sites with a resident population of at least 3000 within the walking distance of 0.5 mile radius. GIS allows us to effectively do that interactively. Figure 10 below illustrates how we may do that.



**Figure 10.** Proximity analysis for site selection

We first create a circular graphic of 0.5 mile radius to overlay on top of the map. We then move the circular graphic around interactively with the mouse, and direct the GIS to select the census blocks with the centroids within the circle, and conveniently calculate the total resident population in the vicinity. GIS effectively turns the type of traditionally tedious chore into an easy task of analytical mapping.

## 6. DISCUSSION

Studies continue to show that today's businesses are looking for IS/IT professionals mature in communication and skillful in analyzing and solving problems (Caputo, Kovacs & Turchek, 2004). Good training in IT skills is undoubtedly a requirement for IS graduates. However, students with a winning edge are those also trained in the intelligent use of information, especially spatial information, for problem

analysis and problem solving. GIS is obviously a good tool for that purpose (Boasson, Boasson & Tastle, 2004).

This paper discussed three hands-on skills of utilizing GIS to analyze retail marketing questions. There are many resources for students to develop GIS skills in the context of retail marketing, including for example GIS textbooks and websites that describe real-world retail applications (Miller, 2007; ESRI, 2010a). Another GIS resource for retailing is ESRI Business Analyst Online, especially the Tapestry Segmentation tool that classifies U.S. neighborhoods into 65 segments based on demographic and socioeconomic characteristics; the student can use this easy-to-use tool to quickly analyze customer preferences in any particular geographic vicinity (ESRI, 2010b; Traore, 2010).

While we focused on the example GIS skills applicable to retail marketing, we have also shown that GIS training is multi-disciplinary. In this section, we will discuss the pre-requisites necessary, and the appropriate emphases, to prepare the student for success in such a GIS course.

GIS is a very special tool for handling large collections of data, especially for spatially related data. Our examples show that the student needs a mature understanding of basic statistics. Without that, the student's learning may be seriously hindered. An introductory level of statistics should be required, although a student may benefit even more by taking a well-designed spatial statistics course incorporating the use of geostatistical tools (Dramowicz, 2010).

GIS is a database system with its very unique graphical user interface for user manipulation of data. In fact, GIS is often thought of as a relational database with the additional capability for handling geometry and topology graphically. The student well versed in relational database or SQL usually finds the knowledge helpful. In practice, however, we do not think the student needs the training of a full course in database systems. Skills in using a spreadsheet will also be helpful in that regard. Our suggestion is for the course to provide extra coverage on the use of data tables, and possibly simple SQL.

Geographers well versed in mapping usually feel that GIS students need to understand various map projections for the purpose of map making (Clark, 2003; Demers, 2005). We however do

not concur. GIS use for business purposes generally works with community mapping. Maps used in analysis and presentation usually are relatively large-scale local maps dealing with states, cities, small neighborhoods or municipalities. Students do need to be aware of the different kinds of projections in use, so that they can work with data from different sources. Very thorough treatment of different projections for mapping will not be necessary, much less the mathematics training in projective geometry, with the exception of engineering students who may want to get into the programming aspect of GIS use. GIS today usually has built-in functions for translation of data sets from one projection to another, sufficient for use in most community mapping. Hands-on experience for the student serves our purpose better.

An interesting but much less discussed aspect of GIS training is in graphic arts design. GIS is a problem solving tool which facilitates the intelligent use of information. Yet the results to be presented usually involve maps. From an engineering point of view, a map is partly geometric, partly topographic, but it is also partly symbolic. To the audience, quite often it also has to be aesthetically pleasing. The choice of colors and the separation of ground and figure are fundamental and essential. We did not discuss that in this paper, although our examples may have high-lighted some of that aspect. Few, but some textbooks also cover the basic principles of graphic arts design (Gorr & Kurland, 2006).

Lastly, effective use GIS depends on one's conceptual skills in understanding spatial information. The IS curriculum needs to help students, when they are analyzing a situation, to think spatially, to ask spatial-oriented questions, such as "What is at ...?", "Where is it located?", "What spatial patterns exist?", "What has changed since ...?", "What if ...?" We need to design the GIS courses in the curriculum to take advantage of the positive relationship between improved spatial thinking and improved problem analysis (Kolvoord, 2010).

## 7. SUMMARY

An important focus of retail marketing is evaluating the characteristics of people who are potential customers. Given the easy access to the relevant digital maps and the publicly available demographics information published by

the US Census Bureau, GIS today is a viable tool for that purpose.

In the IS curriculum today, GIS courses are springing up to offer training for the intelligent use of spatial information, including the identification and analysis of these marketing opportunities. We describe three different approaches to using GIS. Firstly, we present demographics information visually in a map. GIS makes this very convenient. Simply choose the appropriate attribute for the information we want to look into, and we can visualize where the potential customers are located. Secondly, when relevant data gathered from different sources may not be appropriately associated for analysis and presentation, GIS provides the spatial overlay function to create the necessary association by spatial correlation. In our example, it allowed us to present demographics information according to our regional subdivisions. Thirdly, proximity analysis allows us to ask questions about the vicinity. By quickly aggregating information about the vicinity at any location, the use of GIS for the kind of analytic mapping becomes a practicable tool for site selection.

These examples of application show us what we may want to focus on as the important GIS skills set for an IS student in business. While GIS skills involved also show that a course has to be multi-disciplinary, we went on to discuss the different levels of pre-requisite knowledge in different areas of the discipline. Statistics is the most important. Basic SQL and understanding of relational database system would be helpful. Full treatment of map projection standards is not necessary, as long as the different projections relevant to community mapping are covered, and shown how we can use GIS to work with data from different sources with hands-on experience. Basic principles of graphic arts design are also relevant in map presentation. The GIS course has much practical value in the IS curriculum for business.

## 8. REFERENCES

- Boasson, E, Boasson, V & Tastle, WJ (2004) "A New Tool in IS Management: Geographic Information Systems." *Proceedings of ISECON 2004*, v.21, Newport, RI, §.3124.
- Caputo, D, Kovacs, P & Turcsek, J (2004). Defining the Essential Skill and Functional Areas of Study in IT as Measured by a Survey of Field Professionals. *Proceedings of ISECON 2004*, v.21, Newport, RI, §.2215.

- Clarke, Keith C (2003). *Getting Started with Geographic Information Systems*, 4<sup>th</sup> edition, Prentice Hall.
- Demers, Michael N (2005). *Fundamentals of Geographic Information Systems*, 3<sup>rd</sup> edition, Wiley.
- Dramowicz, Konrad (2010). Using Spatial Statistics and Geostatistical Analyst as Education Tools. ESRI Education User Conference, San Diego, CA. Last retrieved on August 10, 2010 from [http://proceedings.esri.com/library/userconf/educ10/educ/papers/pap\\_1464.pdf](http://proceedings.esri.com/library/userconf/educ10/educ/papers/pap_1464.pdf)
- ESRI (2010a) GIS for Retail. Last retrieved August 9, 2010 from <http://www.esri.com/industries/retail/index.html>
- ESRI (2010b) Tapestry Segmentation. Last retrieved on August 9, 2010 from [http://www.esri.com/data/esri\\_data/tapestry.html](http://www.esri.com/data/esri_data/tapestry.html)
- Gewin, V. (2004) "Mapping Opportunities." *Nature*, Vol.427, pp.376-377.
- Glover, B. (2005), "Curriculum Update for GIS Programs in Texas Community Colleges," 5<sup>th</sup> Annual ESRI Education User Conference, July 2005, San Diego, CA.
- Gorr, WL and Kurland, KS. (2007), *Designing Maps*. In *Learning and Using Geographic Information Systems*, Thomason Course Technology, Chapter 4, pp. 137-176.
- Kolvoord, Robert (2010) What Are They Thinking: Students' Spatial Thinking Skills, ESRI Education User Conference, July, San Diego, CA. Last retrieved on August 10, 2010 from <http://proceedings.esri.com/library/userconf/educ10/EDUC/abstracts/a1048.html>
- Miller, Fred L. (2007) *GIS Tutorial for Marketing*, ESRI Press, Redlands, CA.
- North, Matthew A., Samuel B. Fee, Jacqueline M. Bytnar. (2009) "Relational Data Modeling to Enhance GIS-Based Visual Information Systems," *Issues in Information Systems* 10(2), pp.226-230.
- Reames, S. (2005) "Business Geographic Information Systems - A Course in Business Geomapping," *Proceedings of ISECON 2005 v.22* (Columbus OH): § 2334.
- Sinton, D.S. and J.L. Lund. (2007) *Understanding Place: GIS and Mapping Across the Curriculum*, ESRI Press, Redlands, CA.
- Traore, Moussa (2010) GIS in Merchandising Education: Visualizing Customer Data for Decision Making. ESRI Education User Conference, July, San Diego, CA. Last retrieved on August 10, 2010 from <http://proceedings.esri.com/library/userconf/educ10/EDUC/abstracts/a1013.html>
- Wu, Peter Y. & Kohun, Frederick G. (2005) "Designing Geographic Information System Courses in the IS Curriculum," *Proceedings of ISECON 2005 v.22* (Columbus OH): § 2564.
- Wu, Peter Y. (2007) "Introducing Geographic Information Systems into the IS Curriculum: GIS Tutorial and Preparation Workshop," *Proceedings of ISECON 2007 v.24* (Pittsburgh PA): §3732.
- Wu, Peter Y., & Rathswohl, Eugene. (2010) "Address Matching: an Expert System and Decision Support Application for GIS," *Proceedings of ISECON 2010 v.27* (Nashville, TN): §1399