

FINDING A WAY: STUDENT EXERCISES WITH NETWORK ANALYSIS

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ABSTRACT

Many universities and colleges face the problem of helping handicapped students navigate through their campuses. The paper discusses a set of GIS laboratory exercises using Network Analyst to make students aware of the problems faced in developing a geodatabase to assist handicapped students. Aspects of geodatabase design, data collection, topological editing and analysis will be presented.

STATEMENT OF PROBLEM

As I indicated in my presentation at the 2006 ESRI Education User Conference, my general approach to geographic information systems exercises is to have students working on real world problems using data available or built for the local area [Martin, 2006]. As a transportation geographer by training I felt that the students should be introduced to the capabilities of Network Analyst to solve routing problems. Therefore I developed a pair of exercises for my Advanced GIS course which will be focus of this paper. These exercises meet my criteria for a good GIS lab experience because the research and results are relevant and the exercises are challenging.

FIRST NETWORK ANALYSIS EXERCISE

To introduce Network Analyst to the student, they first work through the tutorial on route finding available within the ArcTutor datasets. They then apply this knowledge to determine routes by distance and travel time through the state and federal highway network within the local area. See Figure 1. However prior to using the route finder on this local network, the students have two editing tasks they have to complete. First, they have to add the traffic interchange for the Northeast Extension of the Pennsylvania Turnpike, Interstate 476, with the state/federal highway network. See Figure 2. While the initial data files all came from the Pennsylvania Department of Transportation (PennDOT), there is no interchange with the Turnpike since that road system does not fall under PennDOT jurisdiction. Students are instructed on digitizing the interchange roads in the direction of travel. A DOQQ is used to do the heads-up digitizing. Once the Turnpike has been integrated with the other highways, the second editing task is to make sure that all divided highways have been digitized in the direction of travel. In addition, using the topology of the network they had to ensure that junctions were correctly located to allow interchange between links of the system. Using speed limits for the highways and interchange ramps, the students calculate the travel time on each link in minutes. Once these calculations have been made, I give the students a set of three origin/destination pairs and they determine the routes of minimum distance and minimum travel time between these three pairs of points. The students usually enjoy this exercise since it is a task to which they can relate from their daily lives.

Figure 1. First Network Analysis Exercise Study Area

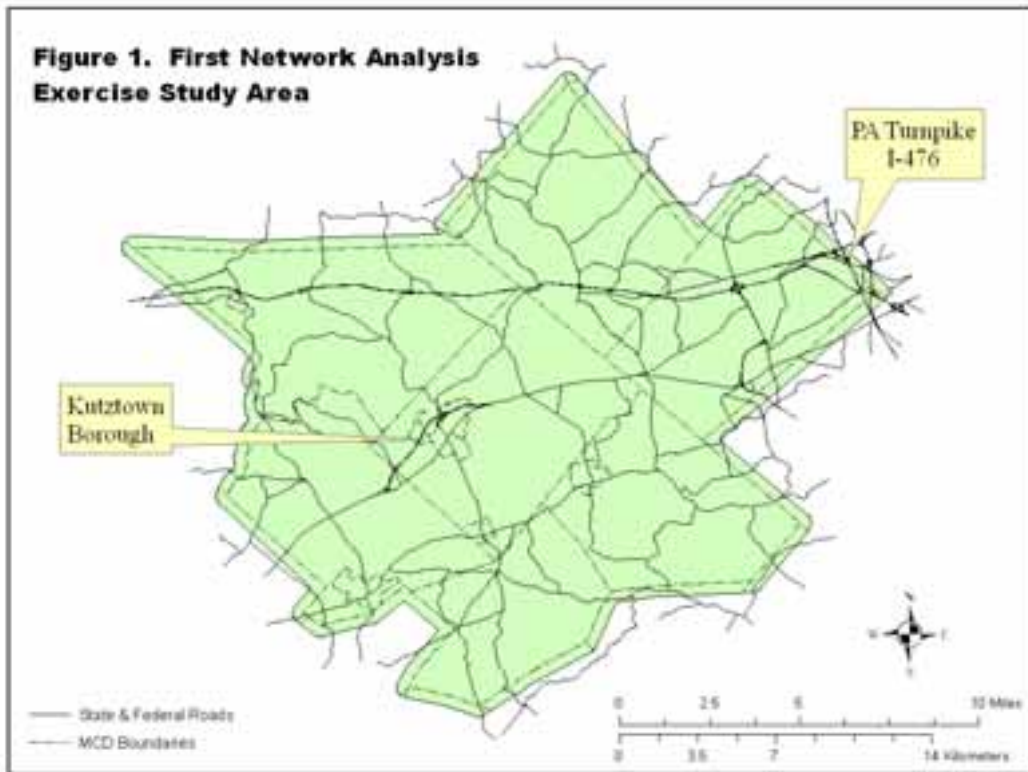
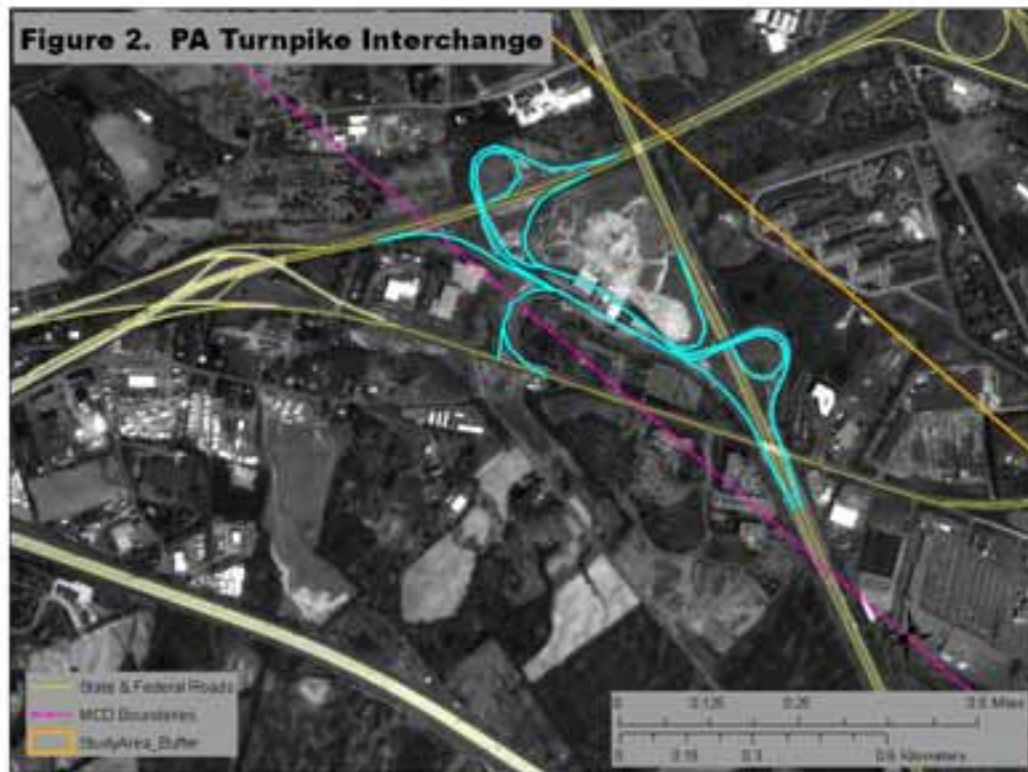


Figure 2. PA Turnpike Interchange

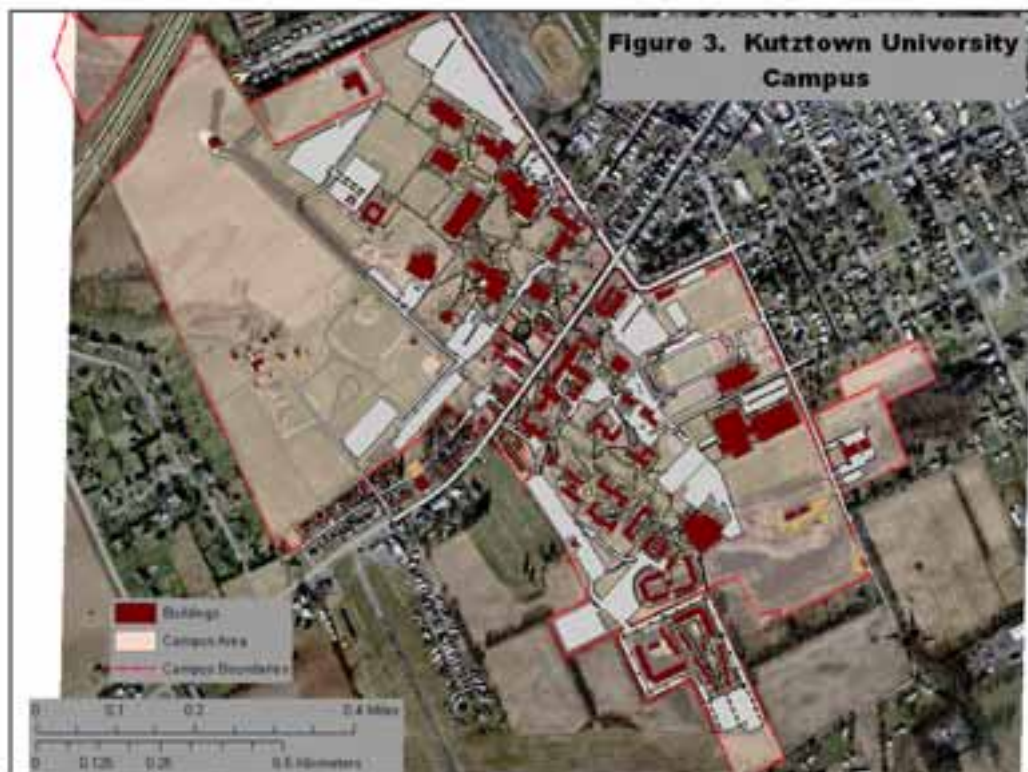


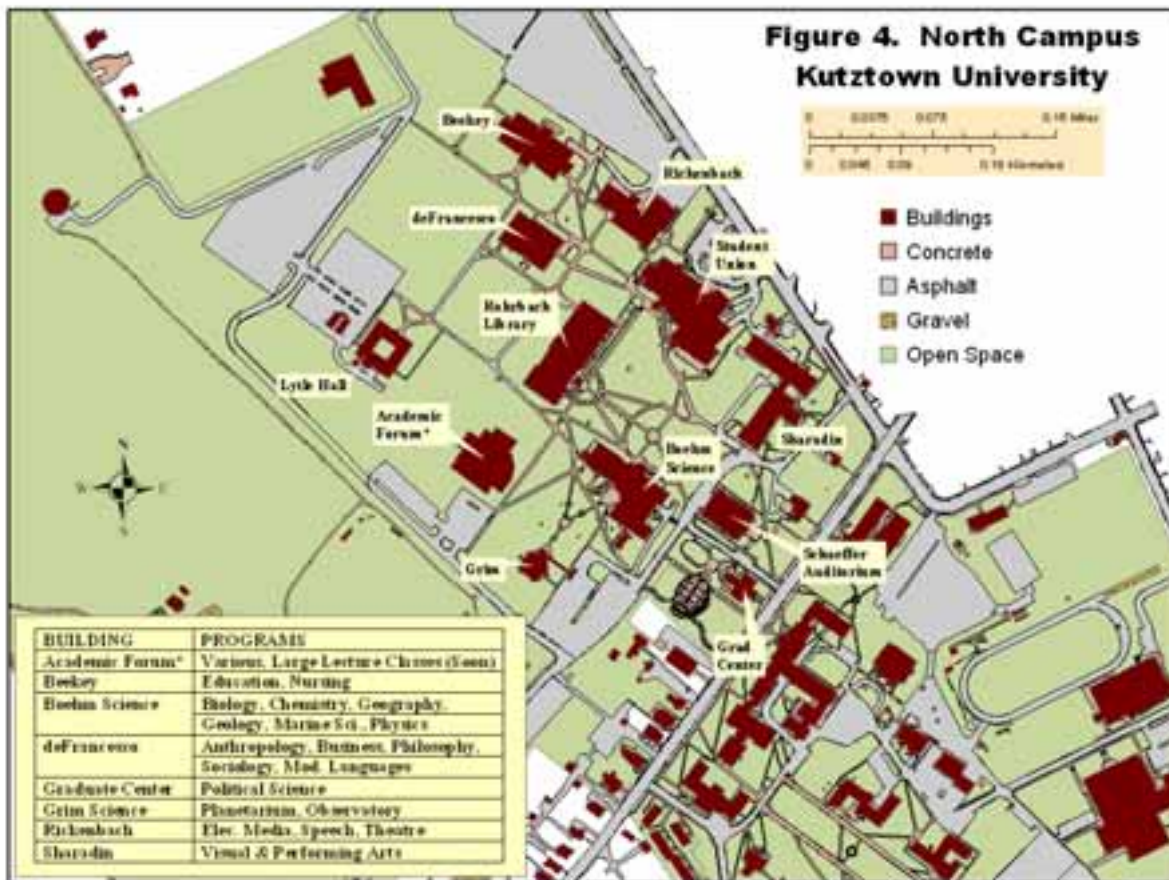
SECOND NETWORK ANALYSIS EXERCISE

The second exercise using Network Analyst moves from the regional scale to the local scale of the Kutztown University campus. See Figure 3. The task given to the students is to develop within a geodatabase, a network data set for the Kutztown campus that will allow an individual in a wheelchair to navigate the campus. A personal geodatabase has been built for campus which includes buildings; sidewalks; parking lots; and open spaces feature classes. These feature classes were drawn from the AutoCAD files maintained by the physical facilities staff on campus and have been spatially referenced. In an earlier exercise the students had learned how to use a GPS to spatially reference and adjust the CAD files for the campus so they are familiar with the data. While the entire campus is available, the students work with the North Campus area. See Figure 4. This area of campus was selected for three reasons. First, this is the area of the campus where most academic buildings are located. Second, this region is also spatial close to the Boehm Science Center where the Geography Department and our GIS laboratory are located. Thirdly, this area is significantly complex to challenge the students.

The primary tasks for the students are:

1. Determine the network paths (links);
2. Determine the network junctions (nodes);
3. Edit the topology of the network to insure interchange between links;
4. Determine the location of barriers for wheelchair students; and
5. Produce a map for North Campus showing the wheelchair paths between the various academic building as well as the parking lots.





Using the North Campus portion of the geodatabase for Kutztown University, the students create two feature classes: one for the paths and the second for the junctions. A nominal (text) attribute field is added to each feature class. Table 1 lists the values that will be recorded for the features.

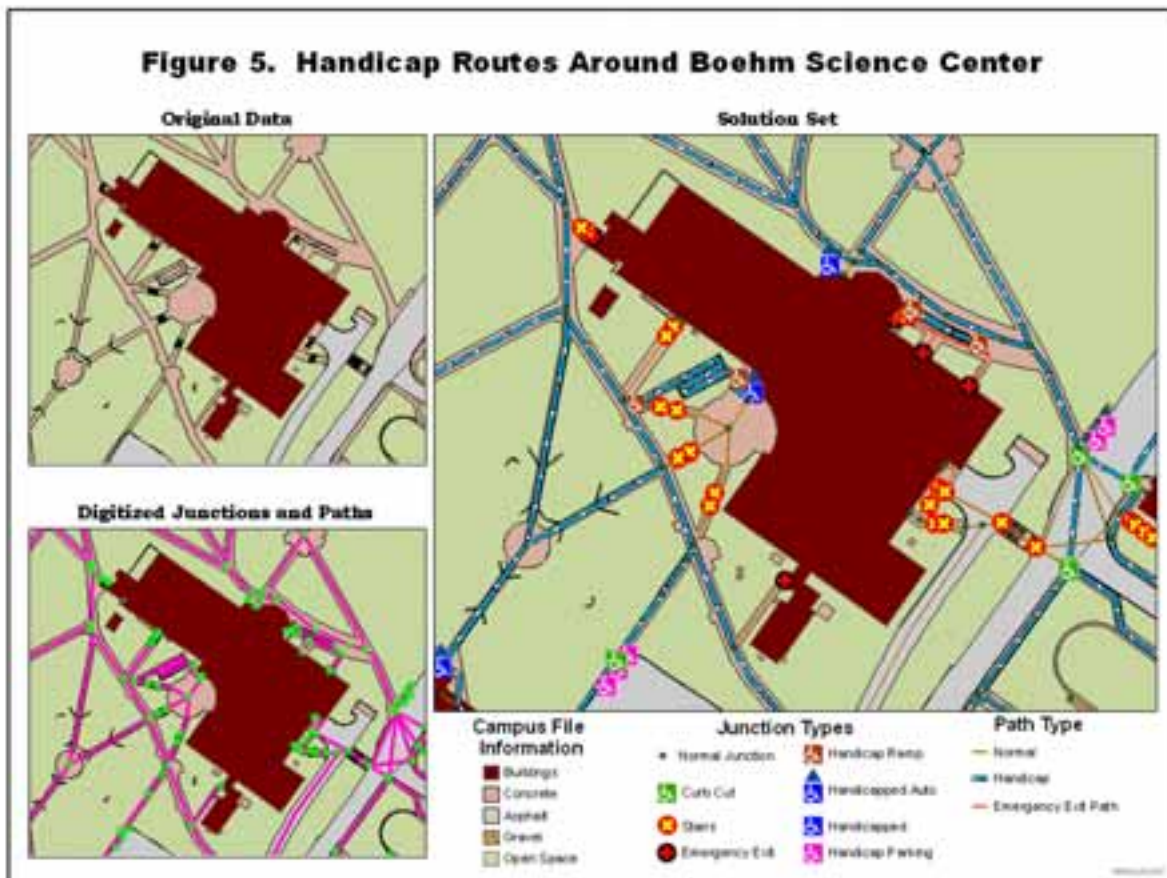
TABLE 1 – ATTRIBUTE VALUES

PATHS	JUNCTIONS
Normal	Normal
Stairs	Stairs
Emergency Exits	Emergency Exit
Handicapped (based on Network Analysis)	Handicap Ramp
	Handicap Parking
	Handicap Building Entrance
	Curb Cuts

Students build the initial set of paths and junctions based on the feature classes available within the campus geodatabase. The students are introduced to the centerline edit function which they find helpful in moving down the sidewalks adding links.

While stairs can be easily identified from the campus files many of the other attributes can not. Therefore once they have built the initial feature classes, they print a map of North Campus on C-size paper. Dividing the students into groups and with their maps in hand, the students are given specific buildings to investigate. The students have to field check and attribute the paths and junctions for the attribute values listed above. They determine which building entrances have automated door openers for the handicapped and which do not. They also have to note the emergency exits for the buildings and the paths associated with these exits. Emergency exit plans in each building facilitates this process. As part of this process the students quickly realize that they do not know the campus as well as they thought. Each group reports back to the GIS laboratory and shares the information they have gathered with the other groups.

Once all the links and junctions are coded by geography and attribute, the students build their network. As part of this process they check the topology of the network and edit it as necessary. I then begin to give the students specific origin-destinations pairs for North Campus. The students use the routing capabilities of Network Analyst to route between the locations. They then determine if there are any limitations to movement along that path such as stairs. If there is a problem, they place a barrier at the appropriate location and recalculate the route. Once a clear route is found the links on that route are attributed as Handicapped accessible. The students then test various paths between different building combinations to determine which links have wheelchair access.



Finally, the student produce map showing all links that have not restrictions for wheelchairs. See Figure 5. As shown the maps also indicate the status of the building entrances, handicap parking, curb cuts, and the presence of stairs. The maps have been shared with the University's physical facilities staff members who are developing maps to be place on kiosks around campus.

CONCLUSION AND FUTURE DEVELOPMENTS

The first network analysis is completed in one two-hour lab sessions. The second network analysis exercise takes three lab sessions with the students doing independent work between lab sessions. One of the aspects of modeling for wheelchair students that is not implemented is the slope of the walkways since the Americans with Disabilities Act places restrictions based on slopes for walkways to be considered wheelchair handicap accessible. While this requirement is not implemented we do discuss how slope could be incorporated into the geodatabase. Given that the campus CAD files do include information on elevation in the form of one-foot contour lines, this may be addressed at a future date. By using public files from the state's Department of Transportation at the regional level and database files for the campus the students are able to see how network analysis maybe used to address routes problems as well as the problem of building network files.

REFERENCES

Robert N. Martin, "What Makes a Good GIS Lab Experience?" Proceedings of the 6th Annual ESRI Education Users Conference, Redlands, CA: ESRI, 2006.

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