Max Mousseau,
Sergio Hernandez
TGIS 415
Matt Kelley PhD.

Streetcar Service Expansion in the city of Tacoma

Theoretical Foundation:

The idea behind this research project was to assess potential routes for streetcar service expansion within Tacoma, Washington. At the time of this analysis, there exists a single route of light rail service that dissects a major portion of the downtown area. There is also a planned expansion to continue service to the area known as the ‘Stadium District’ with an endpoint at Tacoma General Hospital.

Transportation forms a cornerstone of many municipalities long term growth and sustainability plans (Mayors, 2005). Tacoma is no exception, however given the current financial situation in the United States; most cities are struggling with funding sources and the decision of how to direct the funding they have (Council, Meeting Minutes, 2011). The end product of this GIS based analysis aims to provide assistance by alleviating some of the potential cost of route research. It also seeks to further the usage of GIS and the goals of GHG reduction through proper transportation planning.

Planning

Planning for this project began in Jan 2011 with the initial idea and goal outline. Additional academic support for research into the expansion of streetcar service was drawn from the effects that streetcar and light rail have been shown to have in many municipalities (Pearlmutter & Meir, 2010). After group discussion, an initial project workflow was created that incorporated most of the major project procedural milestones. Consideration was also made for the data structure using one primary geodatabase and multiple feature datasets. Figure 1 was created in Gliffy and is color coded with processes and products corresponding to their respective feature datasets.

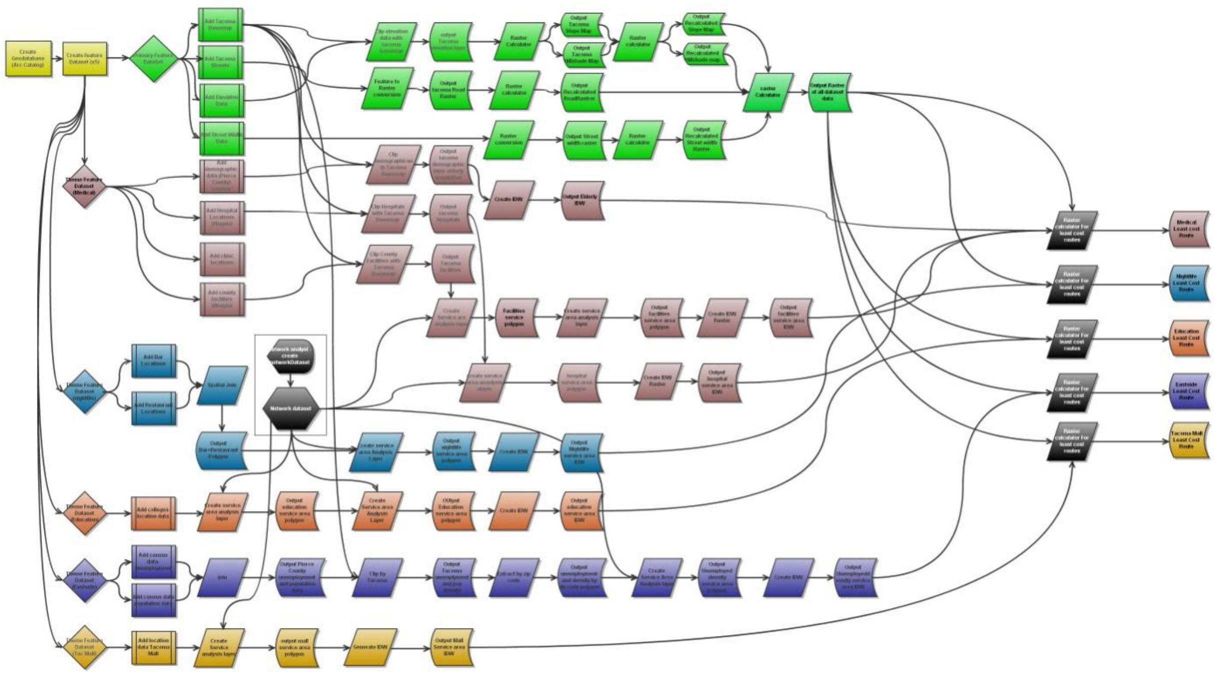

Fig.1

The original idea of themed routes was kept throughout the following three months. This model changed as analysis revealed a more comprehensive and realistic approach to providing potential routes. In the end it was determined that incorporating all of the factors into a total cost and then calculating the routes between existing transit hubs was the best method for cost path calculation.

Initial research was conducted to ascertain which services and demographics would best represent the overall needs of potential streetcar users. After discussion with the course instructor, Matt Kelley Ph.D and peer review in class, it was decided that given the time and resource constraints, we would calculate the following into our total cost for the routes:

Population Density
Medical Facilities and Service Providers
Commercial and Retail
Bars and Restaurants
Elderly Population

Methods

First, we made a geodatabase. In the geodatabase we created a primaryfeature dataset. We projected the feature dataset in NAD 1983 StatePlane Washington South FIPS 4602 Feet. This geodatabase and feature data set was the location in which we would import rasters and shape files.

Second, we collected data. We were able to get the digital elevation (DEM) map from the data given with lab 11 and the Tacoma base map from another previous lab. We obtained the streets polyline file from lab 11. We were able to get some raw demographic data in the form of Microsoft Excel spreadsheets and block group shape files from the Census Bureau's website. We used the decennial census from 2000. We collected the data tables of population count by age, quantity of people with poverty status by age, and total population for each block group in Tacoma. Lastly, we got the locations for all commercial buildings from InfoUSA.

The census data needed some tweaking to prepare it to be read by ArcMap. First, the age data table had to be consolidated. We removed all of the age ranges below 65 and aggregated equivalent values and above. Then, in a new column, we divided the number of people 65 and older by the total population in the block group to get a percentage of elderly population. In the poverty status data table, we aggregated the number of people in poverty. In a new column, we then divided the number of people in poverty by the total population in the block group to get the percentage of people in poverty. To finish preparation, we deleted the second row from each table since it contained neither the data name, nor the data itself.

We had to turn the demographic data into classed raster files. First we joined the three data tables to the block group shape file using their geoid's as a common attribute. Then, for each of the three categories, we made a centroid shape file. For each centroid shape file, we then interpolated the data using inverse distance weighted (IDW) interpolation and a raster resolution of 10. This gave us three raster files showing population, senior citizen, and poverty density gradients. From these raster files, we reclassified them into nine classifications using their natural breaks. We classed them so that the higher their respective density, the lower their cost (1=high density, 9=low density).

Next, we extracted information from the InfoUSA point file and turned them into categorical point layers. To accomplish this, we first selected certain points by what type of service they offered. For example, for the medical facilities layer, we selected all of the points that were classified as a provider any type of medical service. We did this for bars as well. For each category, after we had selected the appropriate points, we exported the data as new point layers.

After creating the individual point layers, we then had to rasterize them. First, for each individual category point file, we used the point density tool to create rasters that showed low to high density areas of medical facilities and bars. We used the same tool to create a point density raster of the InfoUSA information to create a map of commercial hotspots. We reclassified each of these rasters using a classification scale of one to nine with one being the highest density (lowest cost) and nine being the lowest density (highest cost).

The next step we took was to extract and rasterize the streets in Tacoma that could support a rail for the Link. We selected streets with a class of two (freeways were classed as 1 and smaller streets were classified higher than 2) from the Tacoma streets shape file, and exported the data to make a new layer containing only the streets the Link could use. We then reclassed the DEM to make cells with slopes of 8% or less a value of zero and cells with higher slopes one. From this raster, we used the raster to polygon tool to convert it to a polygon shape file. We used the select by location tool to select the Link-usable streets that were within areas in the DEM-polygon layer whose slopes were more than 8%. We converted this new Link-compatible streets layer to a raster by using the feature to raster tool. Then we reclassed the streets raster by valuing the cells with streets at zero cost and the cells without streets at 99 to weigh the raster heavily in favor of keeping the proposed rail to the streets.

The next step we took was to make point layers for the starting locations and destinations of the routes. The origins/destinations we chose were the ferry dock at Point Defiance, the proposed Tacoma General expansion stop, Tacoma Dome Station, Tacoma Community College (TCC) Transit Center, Tacoma Mall Transit Center, and the 72nd Street Transit Center. To do this, we created a new feature for each place and made a single point at the location.

We then made a total cost raster to use when creating a cost distance and backlink raster. Using raster calculator, we created a raster aggregating all of the previous rasters we used. To specify, these were the population density, percentage poverty, and percentage elderly rasters made from the demographic data, the medical services and bars rasters, and the Link-compatible streets raster. We simply added their values since the street file was already classified with a heavy weight. This means that the other rasters had equal weight compared with one another. We made sure to adjust the extent setting to ‘union of points’ to ensure that each raster was fully represented the in the total cost raster.

The final steps in preparation we made were to calculate cost distance and backlink rasters for each starting point. We used the cost distance tool to create these two types of rasters for the Point Defiance, TCC, Tacoma General and Tacoma Dome points. The Tacoma Mall and 72nd Street stations were not calculated in this step simply because they served as destinations in the analysis.

The final step was to create the least cost paths. We used the cost path analysis tool to calculate the least cost paths between the Point Defiance and Tacoma Dome transit centers, the Stadium and TCC transit centers, the TCC and Tacoma Mall centers, the Tacoma Dome and Tacoma Mall centers, and between the Tacoma Dome and 72nd Street stations.

Results

The final product of our analysis resulted in the following 5 routes:

TCC to Stadium primarily via 6th Ave

TCC to Tacoma Mall – zigzag route through south Tacoma

Tacoma Dome to Tacoma Mall via primarily center

Tacoma Dome to 72nd and Portland Ave via Mckinley Ave

Cross town route that begins at the 72nd St. Station and ends at Point Defiance Park (ferry terminal access)

The resulting route calculations were somewhat in accordance with predicted outcomes for each route. There were exceptions such as the sections of route to and from TCC that utilized 12th St. instead of south 19th. Also of note is the cross town route. The purpose of this route was to provide for streetcar service to the areas of highest total cost density from the southern- most transit hub to the northern-most which in the case of Tacoma, is a Washington State Ferry system dock. However given the slope of the approach to the ferry dock, the route calculation used the closest point allowed by the limiting factor of slope. This route dissects the city from south to north in a fairly geographically direct route. It uses the Tacoma Dome to 72nd street route for the first half of the route then heads towards north 21st street and Union. From there the route zigzags until its destination.

Overall all routes were calculated without error and complete the path between points.

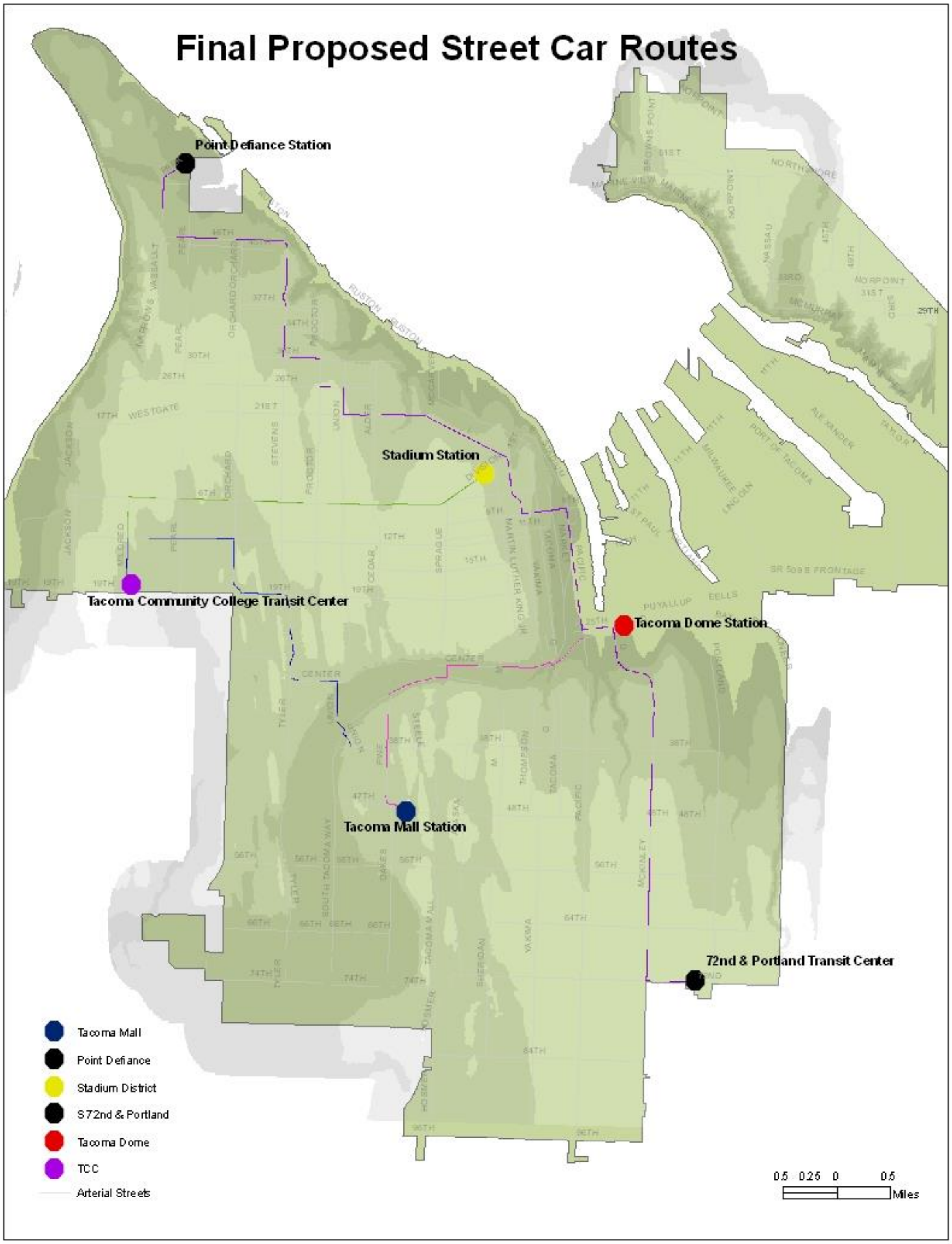
Final Proposed Street Car Routes
Point Defiance Station
Stadium Station
Tacoma Community College Transit Center
Tacoma Dome Station
Tacoma Mall Station
72nd & Portland Transit Center
Tacoma Mall
Point Defiance
Stadium District
S72nd & Portland
Tacoma Dome
TCC
Arterial Streets
0.5 0.25 0 0.5
Miles

Fig. 2

Critical Analysis

The overall result of the analysis was as hoped. There are still many factors that could be better addressed through incorporation of more demographic and socio-economic factors in order to produce a more comprehensive total cost file with which to calculate the routes. The issue at hand becomes how much and what kind of data is enough? This is an issue that was addressed by Crampton and Krygier when analyzing the political nature and impact of cartographic products, " Here, the practice of the cartographer is immediately political." The critical approach is therefore an ethos and a practice, a Kantian process of questioning." In this instance, cartographic products were used as a tool of misinformation. This point although not necessarily in the same genre of analysis subject illustrates the point that any cartographic product can have profound social and psychological impact on those who view and use it.

This product could result in some people feeling ostracized or neglected, but the end result of any spatial product is to represent the data in a meaningful and useful way. What data is used and who performs the analysis is the variable that influences the final product and who and for what reason views the product decides its interpretation. It is a constant paradoxical struggle that we attempted to address as best possible through providing rail access to the most services and individuals.

Works Cited

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