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Taking on the "T": Transforming Worcester Transit

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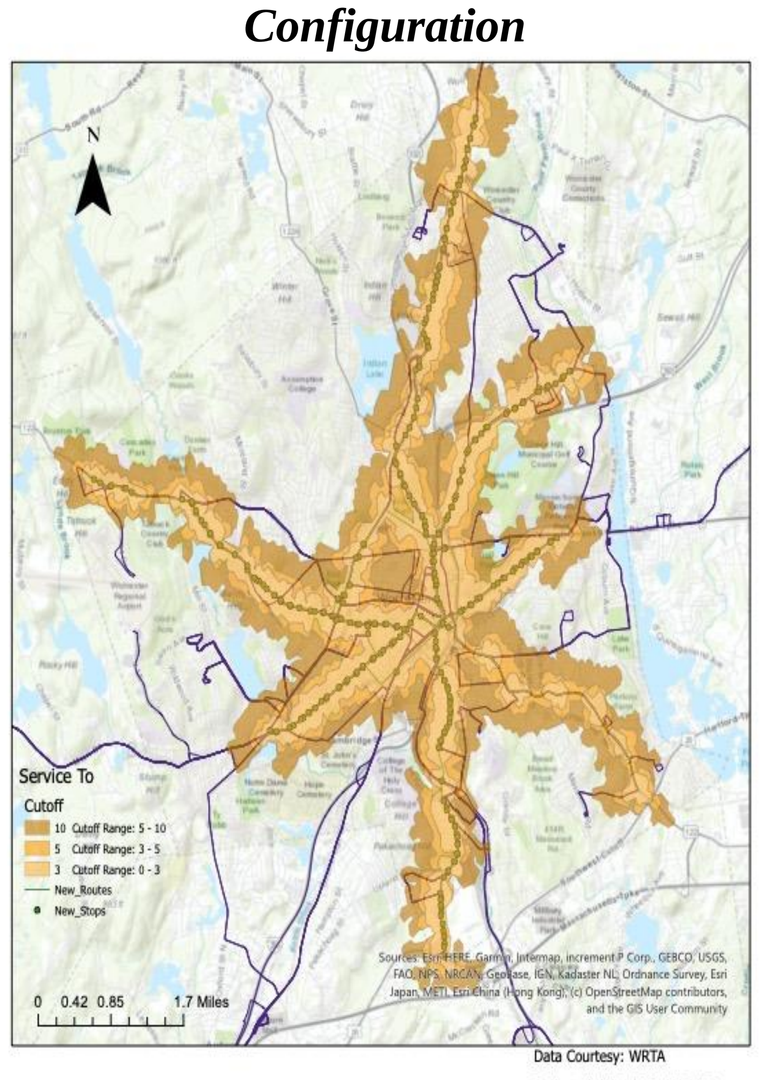
(Sponsors: Professors Dana Bauer and Wayne Gray)

Abstract

By centering smart design principles, the WRTA has a cost neutral path to become an industry leader. The following poster provides a sneak peak at an ongoing comprehensive operations analysis that outlines the necessary steps to have a transit system with comparable geographic coverage but with far superior service. According to my model, currently one can expect a trip by bus to be roughly 277% longer than a trip by car. Furthermore, one can expect full service only on weekdays and with the most frequent lines coming at 30-minute intervals. However, by changing the shape of the network, consolidating redundancies, and instituting a few one-time improvements one can expect the following for every line in Worcester: faster service, 10 - minute frequencies, service 18 hours a day, and full- service every day of the week.

** Study Area is Worcester proper, lines outside Worcester run the same leaving at the top of the hour*

Recommended Route Configuration



Methodology

Demographic Maps of Worcester and WRTA
In order to understand where buses should go one needs to locate key populations and areas of interest. Thus, basic choropleth maps of population density, business locations, elderly populations, median income, schools, and rates of car ownership where conducted. Additionally, basic characteristics of routes in town, most notably regarding frequency, subsidy, current ridership, and length.

Accounting for Public Feedback in a Pandemic
Public comment and rider input are critical components of understanding any public service. In order to take appropriate safety precautions without biasing those riders who have access to an internet connection, I chose to use a computer program written by my friend and colleague Kathy McKim in order to comb through and organize public comments in the 2015 Regional Transit Plan.

Network Analysis of the WRTA
Using the ArcGIS network analysis toolbox redundancies in routing were identified by creating differing encashment zones of distance to and from bus stops.

Projecting New System Cost
Leveraging data on route distance, run time, hours of operation, and cost per revenue hour (US DOT, 2019) total system cost is projected and compared with the current cost of operation. The outcome of this analysis includes multiple scenarios involving variable route frequency, variable hours of operation, and variable speed. This analysis is elaborated on further in the Results section.

Stochastic Model
25 randomized sets of Point A to Point B data points were routed using Google Maps to determine which mode of transit be it walking, biking, busing, driving, or a combination of the aforementioned is the most efficient way to get from Point A to Point B. Where applicable, times were sampled at 8 am, 12 pm, and 5 pm and split into "best case" and "worst case" models. The matrices outputs are then used to estimate transit mode use (walk, bike, drive, bus) with the new system. Future versions will include more sets of data.

Global Outcomes – Health, Wealth, Emissions
Using the testing model above, estimated ridership numbers are utilized to project the effect on the health, wealth and emissions of the residents and the environment of the town. In most instances, it's simply a matter of plugging in the necessary values. For example, the EPA annually updates the emissions of an average vehicle in the US commercial fleet.

Recommended Measures

Recommended Route Configuration (pictured to the left): This Configuration was selected based on the following criteria: on existing high use routes, on wide roads capable of multimodal transit upgrades, are roughly equidistant geographically, and near locations of interest. The map colors indicate walking distance to a bus stop (0-3 minutes, 3-5 minutes, or 5 to 10 minutes).

Traffic Signal Optimization

After consulting with the appropriate city agencies, it became apparent that all buses are equipped with the technology to bypass traffic lights. By consolidating lines, this goes from a complicated and lengthy endeavor to a straightforward common-sense initiative saving significant amounts of time and consequently improving bus speeds.

Bus Stop Upgrades

Current bus stops have limited visibility and are inaccessible for vision impaired residents. Additionally, the majority of bus stops are "naked" bus stops without any amenities. This provides an opportunity to generate "stop" sponsorship and subsequent buy into the system by the community. Additionally, signage could be printed in multiple languages, indicate frequency, and direction to improve the legibility of the system.

**** All improvements are supported by federal block grants earmarked in the final report***

Preliminary Results

Stochastic Passenger Model

Mode	Best Case	Worst Case
Walking	-	-
Biking	-	5%
Driving	100%	75%
Bus Original	-	-
Bus New Configuration	-	-
Bus+Bike	-	-
Bus+OnDemand	-	20%

The above table is the output of the stochastic model. While the results remain tentative as the final version is prepared, the model simulates what transit choice a person might make. The best-case scenario highlights choices made in ideal traffic conditions and the worst-case highlights what choices might be made in heavy traffic. Thus, 20% of people with cars are likely to take the new bus system on heavy traffic days if On Demand Service were also adopted by the WRTA. On Demand Service while not included in the cost scenario above and to the right is discussed in-depth within the report.

Global Outcomes Example: Emissions

Average Emissions Per Vehicle, Gasoline and Diesel Fleet	Kilograms per Mile	Reduction in Vehicle Miles	Pollutants Saved Daily (tons)	Pollutants Saved Yearly (tons)
Total HC	0.000	455400	0.196	71.395
Exhaust CO	0.005	455400	2.154	786.108
Exhaust NOx	0.001	455400	0.423	154.448
Exhaust PM2.5	0.000	455400	0.013	4.788
Brakewear PM2.5	0.000	455400	0.002	0.635
Tirewear PM2.5	0.000	455400	0.001	0.252
Carbon Dioxide	0.404	455400	183.982	67153.284

Data: *Courtesy of the EPA*

Projecting New System Cost

Cost Scenario: Minimum 10-minute Frequency, 18 hours a day, Full Week Service

Scenario	Cost (millions)
Existing system	$20.2
New System, current speed	$33.099
15 mph	$28.782
20 mph	$24.285
25 mph	$20.777

Cost Scenario: 18 hours a day, Full-Service Monday - Saturday, 20-minute Sunday

Scenario	Cost (millions)
Existing system	$20.2
New System, current speed	$29.045
15 mph	$25.252
20 mph	$21.306
25 mph	$18.229

Cost Scenario: Minimum 10-minute Frequency, 14 hours a day, Monday - Saturday

Scenario	Cost (millions)
Existing system	$20.2
New System, current speed	$19.429
15 mph	$16.895
20 mph	$14.255
25 mph	$12.196

Cost Scenario: Minimum 30-minute Frequency, 14 hours a day, Monday - Saturday

Scenario	Cost (millions)
Existing system	$20.2
New System, current speed	$8.659
15 mph	$8.448
20 mph	$7.919
25 mph	$7.233

Conclusion

The final report will be presented to the Worcester City Council with the hope of improving the quality of service for residents who use the system and to highlight quantifiable benefits that system adoption may offer the city. Depending on the extent of measures adopted, quality of service is likely to increase, while reducing operating expenditure as observed in the above cost scenarios. Due to limited space, the categories included here are simply a sneak peak. The final report includes additional content like an in-depth interdisciplinary literature review, an analysis of the chronically undercounted customer base in Worcester, and the contemporary policy landscape including FareFree Worcester.