Identifying Excess Road Widths

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Introduction

The characteristics of Streets are the most important aspects of not only the transportation networks of the American City but one of the strongest determinants of the form and function of it's urban character. The nature of the streetscape has become a topic of contemporary discussion and critic as the perception regarding street function and form is steadily evolving. Proponents of New Urbanism and most famously the urbanist Jane Jacobs have argued that the design of streets is one of the most important aspects of public life. Traditionally the design fo streets in the United States has served divisive interests with the automobile taking prime precedent at the expense of neighborhood character. In the 60's and 70's, highways were strategically placed to cut through underserved communities thereby destroying the land capital and fabric of those identities. Additionally, lane widths and demarcations were designed to improve vehicle speeds at the peril of the pedestrian. With time, this has resulted in American streets being highly dangerous pedestrian environments.

Contemporarily, there is a plethora of thought that seeks to redesign the streets to accommodate community interests. Programs such as 'Safe Streets for All' advocates street use by multipe users such as bicyclists, pedestrians, the differently-abled and children. In the fight against Climate Change, the switch from automobile to energy-efficient forms of transport such as walking and bicycling must be undertaken for short distance trips and Cities must encourage such lifestyle changes. But the expansion fo sidewalks and bikelanes are an issue that limits connectivity. This is due to a lack of financial capital for redesign or a lack of data on the most important links and roads that must be redesigned to develop lanes. Therefore, cities must catalog their streetscapes and current scenarios to understand future potential.

In the ' Value of Residential Streets', Dr. Adam Millard-Ball exposes the high cost of public land that is serving streets in different counties in the United States that be used to expand housing values and opportunities. In this project, I intend to use a similar approach to identify the widths of different streets in the city of Atlanta by understanding what the excess width dedicated to streets are. For instance, several lanes in the city have been traditionally designed for overcapacity such that there exist lane widths of 13'. This is more than the current required width and norm at 10'6". For a two lane road with existing sidewalks this provides an opportunity to incorporate a bike lane by curtailing lane width to the current standard. If sidewalks did not exist, a sidewalk could be added to create a ADA-compliant asset 5' wide. An illustration of the same is shown below. **This sort of redesign requires an understanding of how much space exists in the public realm that is over-engineered or under-utilised.**

Credits: ResearchGate

While cities have lane data on most of its roads, it does not include data on the lane widths. This creates a data gap in the ability for transportation planners to adequately plan for network redesigns. The methodology discussed below shows us the way to calculate excess width and subsequently understanding potential for redesign while not hampering road connectivity i.e removing any of the existing number of lanes.

Methodology

- Identify Parcel Data from the city of Atlanta. Parcel Data is regularly updated and recorded as it is an important aspect of the City's revenue. Several discrepancies exist in recording. In some cases, Sidewalks exists as part of the parcel as 'privately owned public space' while in other cases it exists outside the parcel. For this project we are going to consider that the former is the narrative as it presents a limitation of the data.
- Identify Street Centerline shapefiles with lane number information included. For Streets without lane number information, assume lane number as zero and identify maximum number of potential lanes post the calculations.
- Create a Street Centerline buffer of a maximum width of a six lane road which is the road width of a state arterial such as Ponce De Leone Avenue. Most roads fall within this width with lesser number of lanes. For roads with a greater number of lanes, we neglect the calculation as it generally is a characteristic of a freeway or highway.
- A clip is undertaken using the parcel polygons shapefile. The resultant remaining buffer is the area of the concerned streets.
- The width coordinates of the buffer rectangles are extracted and then attached to the street centerline shapefile. Streets may have different widths on either side. The minimum value is considered to be the true width to maintain fidelity across the entire length of the street.
- Excess width is calculated by multiplying number of lanes with the FHWA updated standard and subtracting it from the excess street value, thereby providing the excess width value.
- A few examples of redesign using the extracted values are undertaken. A google satelite view of the selected streets provides respective configurations. A redesign using the new width is undertaken.
- A standard of all the necessary non automobile interventions and street elements are documented. For reproducibility, a function is written to provide the user with information on all possible element configurations.

Code

The Scripting for this project is simple and deals with only Vector Data.

> 📢 Datasets used are Street Centerline Dataset and Tax Parcels 2017 Dataset from Fulton County Open GIS Portal. The Downtown area of Atlanta is used for representation.

```
# The Dataset & Workspace are prepared is prepared for Execution
import arcpy
arcpy.env.workspace = "Z:\Python_Project"
arcpy.env.overwriteOutput = False

# Shapefiles are loaded for Manipulation
streets = "Street_Centerlines.shp"
parcels = "Tax_Parcels_2017.shp"

#Existing datasets are searched for understanding data values

cursor = arcpy.da.searchCursor(streets, ["Lanes"],["Lane_Width"])
```

```
for row in cursor:
    print(row[0],row[1])

# It is found that the Lanes vary from 12 to 2 with the maximum number of lanes
# hovering around the 2 lane width which is to be expected.

# Additionally we find that lane widths follow old standards of 12 feet. Therefore,
# a 2 lane road measures around 24 feet. We want to understand how much wider this is in reality.
# We begin with the data manipulation

# CREATING PARCEL & STREET CENTERLINE BUFFERS
# Buffers of Dissolved 100 Feet Land Parcel Buffers and
# undissolved 100 Feet (Assuming Street Maximum Width of 6 Lanes) Centerline Buffers are created.
# The Prompt for the Buffer GeoProcessing Tool is followed

arcpy.analysis.Buffer(in_features=streets, out_feature_class=streets_Buffer, buffer_distance_or_field="100 Feet", line_sid
e="FULL", line_end_type="FLAT", dissolve_option="NONE", dissolve_field=[], method="PLANAR")
streets_Buffer = "C:\\Users\\Siddharth\\GIS_Working_Directory\\Python_Project\\Python_Project.gdb\\streets_Buffer"

arcpy.analysis.Buffer(in_features=parcels_3_, out_feature_class=parcels_Buffer, buffer_distance_or_field="100 Feet", line_
side="OUTSIDE_ONLY", line_end_type="ROUND", dissolve_option="ALL", dissolve_field=[], method="PLANAR")
parcels_Buffer = "C:\\Users\\Siddharth\\GIS_Working_Directory\\Python_Project\\Python_Project.gdb\\parcels_Buffer"

#Note: Several Rows had no Lane Information therefore we get rid of those for clarity and data fidelity.
# Now the Clip Geoprocessing Tool Format is followed to create the intersection between
# Street Buffers and Parcel Buffers to select the polygon between the parcels

arcpy.analysis.Clip(in_features=streets_Buffer, clip_features=parcels_Buffer, out_feature_class=Streets_Clip, cluster_tole
rance="")
Streets_Clip = "C:\\Users\\Siddharth\\GIS_Working_Directory\\Python_Project\\Python_Project.gdb\\streets\\Streets_Clip"

# CALCULATING FIELDS & EXCESS WIDTH

# Sample Calculation: If Lanes are 2 then Lane Width is 24 Feet.
# If Width of Street Buffer is 30', then Excess Width is 6 Feet.

# Area and Road Length Existing Geometries Exist in the Tabular Data
# Calculating Length in Feet from Provided Miles Field. We do not need to use Geometry Tokens - SHAPE@LENGTH
streets_Clip2 = arcpy.management.CalculateField(streets_Clip, field="Length_Feet_", expression="!Miles!*5280", field_type
="DOUBLE")

# Calculating NEw Width from Area and Length of Polygon
streets_Clip3 = arcpy.management.CalculateField(streets_Clip2, field="New_Width", expression="!Area_New!/!Length_Feet_!",
 field_type="DOUBLE")

# Calculating Excess Width
streets_Clip4 = arcpy.management.CalculateField(streets_Clip3, field="Excess_Width", expression="!New_Width!-!Lane_Widt
h!",field_type="DOUBLE")

# Feature layer is added to ArcGIS Pro for Visualisation and Exported.
arcpy.management.MakeFeatureLayer(in_feature = streets_clip4, out_layer = Streets_Buffer_Polygons, {'Lanes >= 0'}
```

Label	FuncClass	Perimeter	Length	New_Width	Excess_Width	Original_Width
Collier St NW	Local	485	182	51	27	24
Joseph E Boone Blvd NW	Collector	333	107	56	32	24
Lawton St SW	Collector	1039	460	58	34	24
Westview Dr SW	Collector	684	277	51	27	24
Peeples St SW	Local	741	250	36	12	24
Hammock Pl SE	Local	621	236	30	6	24

The above is a sample from the attribute table. All Units are in Feet unless otherwise specified.

Analysis & Interpretations

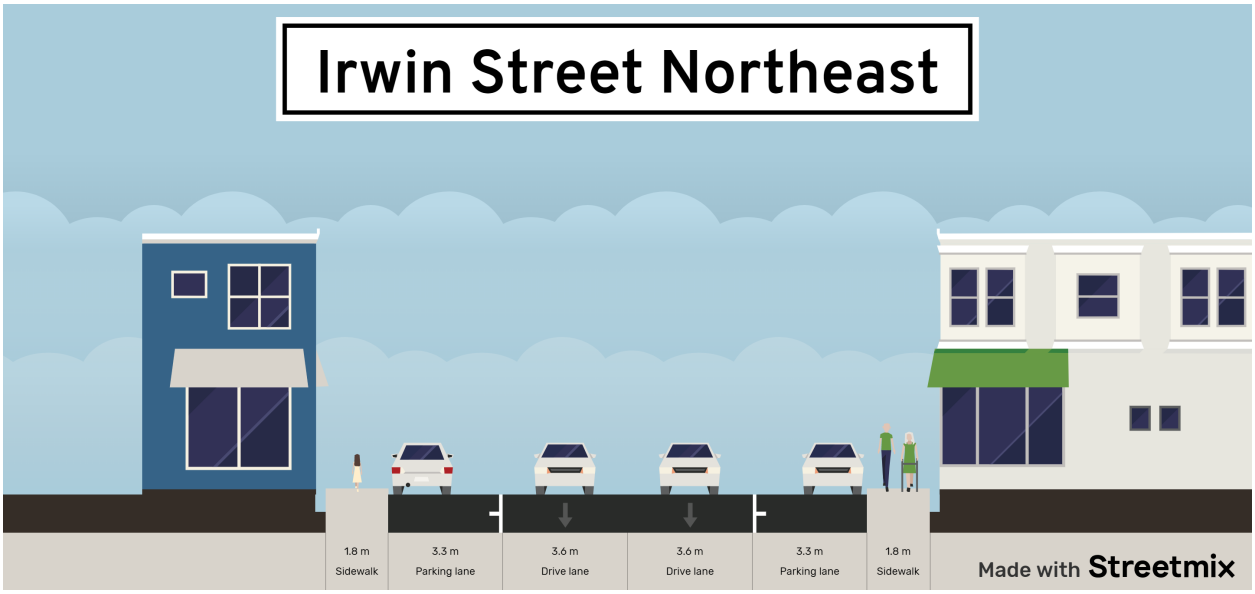
Visualizing the Excess Width Field in 3 Bins for the Inman Park and surrounding areas shows that almost all roads have road widths measured from parcel to parcel in excess of that required for lanes. We neglect the yellow segments as they show negative values potentially arising from non-rectangular polygons and short segments contributing to error. These are discussed in the limitations.

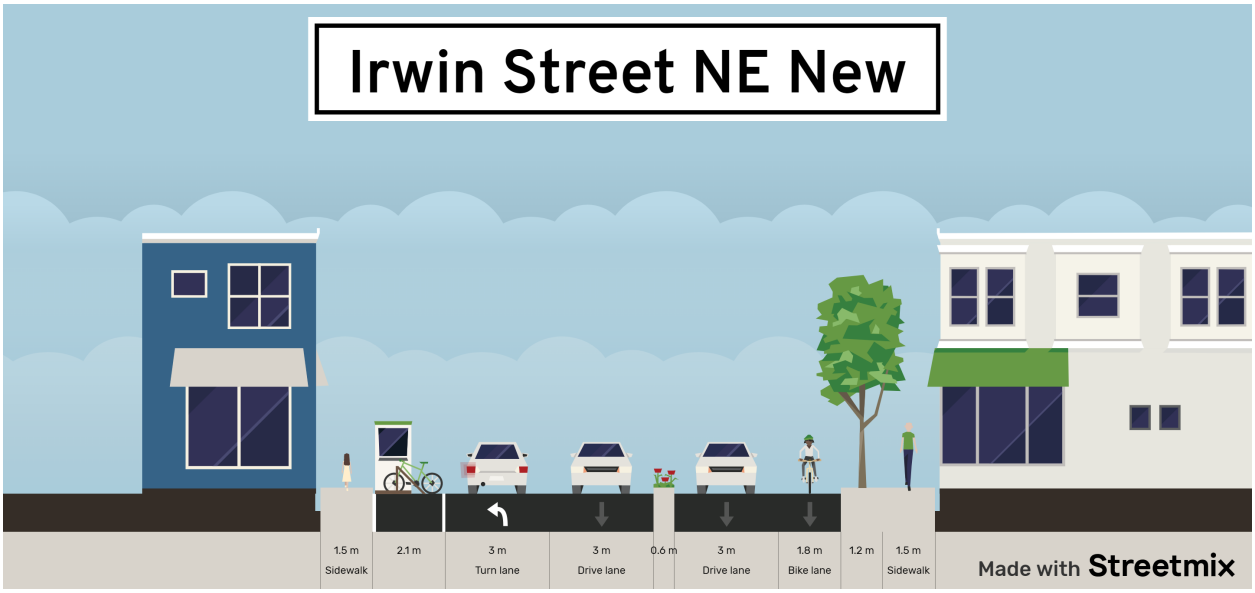
For our Case study - let us consider a segment of Irwin Street NE between Jackson Street NE & Boulevard Street NE. **The Excess Width associated with this road is 35 Feet and is classified functionally as a collector.**

> 📢 The comparison between the Google Map Measurement and our Data Analysis is shown to be 5 Feet. (55 Feet ~ 50 Feet) This proves that the methodology works with minimal error. This is likely due to a portion of the sidewalk being considered a part of the private land parcel.

Using this Data a Cross-Sectional Redesign of the Street may look like the images shown below.

Bike Lanes and Street Elements such as Boulevards can be added by restricting lane lengths.





!! This analysis can be replicated with parcel and centerline data provided lane width data exists. A linear Referencing System or Transportation Network can be created such that Transportation Planners can use calculations of Excess Width to understand where the potential for new bike lanes or pedestrian pathways are in the interests of creating ‘Safer Street for All’ and restricting Speeding Behavior. This analysis has to be reproduced for other locations of the city and reassessed for other cities.

Limitations

- Lane Width data may not be updated or correct. This severly restricts the calculation of excess width.

- Short segments give highyl inaccurate results. The Methodology needs to be revised to accommodate this shortcoming. This is the reason several segments have 0 and lesser values. Centerline Data needs to be reworked for fidelity.
- Sidewalks can be considered private or public property and is reflected differently in different parcels based on measurement. Therefore, this limits the analysis and has ot be supplemented by aerial mapping and assessments.