Connectivity Decisions Based on GIS & Transportation Data

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Federal Transit Administration
Ladders of Opportunity
Connectivity + Accessibility Measures

• How long it takes and how much it costs to accomplish daily tasks
• How well the transportation system connects people to places they need to go
• About 3.6 million Americans miss or delay medical appointments every year
• Improve healthcare access including access for disadvantaged individuals
Connectivity + Accessibility Measure

Quality/Quantity of Public Transport

Level of Need

Over-supply?

Problem Areas

Source - Public transport needs gap analysis by Graham Currie
Examples of Accessibility Measure

• **Analytical Tool (Regional)**
  1. Transit Service Provided vs Demand – DVRPC
  2. Minneapolis/St. Paul Route-level Analysis – Metro Transit
  3. Portland, OR Bike-Path Analysis – PSU Transportation Center
  4. Denver Regional Equity Atlas – DRCOG

• **Analytical Tool (Nationwide)**
  5. Accessibility Analysis Tool – Accessibility Observatory, UMN
  6. EPA’s Smart Location Mapping – EPA Smart Growth

• **Academic Literature**
  7. Public Transit Needs Gap Analysis by Graham Currie
Steps in Accessibility Analysis

- **Origins**
  - Total Population
  - Low Income
  - Minority
  - Elderly
  - Persons with Disabilities
  - Transit Dependent

- **Destinations**
  - Employment Centers
  - Medical Facilities
  - Educational Institutions
  - Social Services

- **Services**
  - Public Transit
    - Local /Express Bus/BRT
    - Commuter Rail/Metro
  - Bike Network
  - Walk Network

- **Gaps**
  - Demand/Need
  - Supply (Quantity & Quality)
  - Gaps Analysis

- **Possible Solutions**
1. Delaware Valley Regional Planning Commission (DVRPC) Analysis

**Steps in the Process**
- Transit Demand Estimation
- Transit Supply Estimation
- Analysis
- Gaps Identification

**DVRPC Model**
- 25 Counties
- 3,400 TAZs

**Data Source**
- GTFS
- OpenStreetMap (OSM)
- Regional Data

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Development of a Regional Forecasting Model Based on Google Transit Feed – Christopher Puchalsky, et.al.
1. DVRPC Analysis (Cont…)

Transit Demand Scores

TAZ-level Transit Demand =

\[0.4 \times \text{pop/acre} + 0.09 \times \text{jobs/acre} + 0.74 \times \text{0-car HH/acre}\]

(Uses population density, job density, and density of 0-car households to assess likely transit demand)
1. DVRPC Analysis (Cont…) 
GTFS Network
1. DVRPC Analysis (Cont…)

Transit Supply Scores

TAZ-level Transit Supply = 24-hour transit vehicle departures by TAZ (from GTFS Data)
1. DVRPC Analysis (Cont…)
Transit Service Provided vs. Transit Service Demanded
2. Metro Transit (Minneapolis & St. Paul)

http://www.metrotransit.org/sip
2. Metro Transit (Minneapolis & St. Paul)

**Metro Transit Bus Service Improvement Plan.**

- **Productivity** (50%-existing population, existing employment, job concentration….)
- **Social equity** (25%-low-wage jobs, service to low-income and minority population, disabled person, 0-car household)
- **System connectivity** (25%-new population served, key destinations served, connecting routes, educational institutions, off-peak and span of service)

http://www.metrotransit.org/sip
2. Metro Transit (Cont…)

<table>
<thead>
<tr>
<th>Route Number</th>
<th>Route Type</th>
<th>Productivity</th>
<th>Equity</th>
<th>Connectivity</th>
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</tr>
</tbody>
</table>

Overall Score: High, Medium, High
2. Metro Transit (Cont....)
2. Metro Transit (Cont....)
3. Portland-Equity Analysis of Bicycle Plan

https://www.portlandoregon.gov/transportation/article/264747
3. Portland-Equity Analysis (Cont..)

Where high poverty/low-income people live & bikeway miles/sq.mile
3. Portland-Equity Analysis (Cont.)

Where high minority/low-income people live & bikeway miles/sq.mile
3. Portland-Equity Analysis (Cont..)

Where high youth/low-income people live & bikeway miles/sq.mile
3. Portland-Equity Analysis (Cont..)

Where high elderly/low-income people live & bikeway miles/sq.mile
3. Portland-Equity Analysis of Bicycle Plan

283 Built Bikeway Miles in 2009

430 Existing, Funded and In-Planning Bikeway Miles

Portland's Bikeway Network

LEGEND
- Off-Street Trails
- Greenways
- Separated In-Roadway
4. Denver Regional Equity Atlas

- Uses GTFS, ACS 2007-2011 and LEHD Data
- The users can create maps showing the region’s major origins and destinations in relation to the **current and future transit network**.
- It generates reports on demographic and economic data.
- The Atlas emphasizes the accessibility to region’s economically disadvantaged residents.
- The future transit network shows connection to jobs, healthcare providers, schools, grocery stores, parks and other essential destinations.

http://www.denverregionalequityatlas.org/
4. Denver Regional Equity Atlas (Cont...)

- Base Maps
- Boundaries
- Demographics
- Education
- Employment
- Health
- Housing
- Transportation
  - Bike Routes
  - Bus Routes
  - Bus Stops
  - Existing Light Rail
  - Future Bus Rapid Transit
  - Future Rail Lines
  - Rail Stations

Active Layers
- Rail Stations
- Future Rail Lines
- Future Bus Rapid Transit
- Existing Light Rail
- Tracts
5. Accessibility Observatory - UMN Study

- Accessibility calculations are performed for every block in a given metropolitan area
- Pedestrian network from OpenStreetMap.org
- Transit Schedule – GTFS
- Labor and Employment - LEHD
- Travel time calculations performed by OpenTripPlanner.org using access, transfer, wait and In-vehicle times.

http://access.umn.edu/
5. Accessibility Observatory-UMN (Cont…)  
Number of Jobs within 30 minutes – Washington, D.C.
6. EPA’s Smart Location Mapping

• EPA’s Smart Location Database (SLD) is a nationwide geographic data resource for measuring location efficiency of various places.

• Data sources used to develop SLD:
  – TIGER
  – 2010 Census; ACS; LEHD
  – HERE
  – Protected Areas Database of the United States (PAD-US)
  – TOD Database
  – GTFS

• It includes more than 90 attributes – residential and employment density, land use diversity, access to destinations, and distance to transit.

• SLD can be downloaded for the entire nation or for a single state, metro region, or locality.

http://www.epa.gov/smartgrowth/smartlocationdatabase.htm#SLD
6. EPA’s Smart Location Mapping (Cont..)
6. EPA’s Smart Location Mapping (Cont.)

Contents

- Access to Jobs and Workers via Transit
  - Accessibility Index - Transit to working-age population
  - Population accessible by transit
  - % of population accessible by transit
  - Jobs accessible by transit
  - % of regional jobs accessible by transit
  - Workers accessible by transit
  - % of workers accessible by transit
  - Low-wage workers accessible by transit
  - % of all low-wage workers in region accessible by transit
  - Low-medium wage workers accessible by transit
  - % of all low-medium wage workers in region accessible by transit
7. Transit Needs Gap Analysis

This paper presents an approaches that measure the geographical distribution of transport needs and compares this with the distribution of public transport service availability/quality.

Graham Currie
Monash University, Australia
TRR#1895, 2004

http://trb.metapress.com/content/j07q2m7121792075/?genre=article&id=doi%3a10.3141%2f1895-18
### Need Indicator – Person Type

- Adults without cars
- Persons Aged 60+
- Adults on Low Income
- Adults in the Labor Force
- Students
- Persons on Disability Pensions

### Trip Purpose Destinations Used

- CBD – Hobart CBD
- Pools – public swimming pools
- Shops – major groups of shops
- Universities – major tertiary education facilities
- Sports – key recreational sporting facilities
- Pharmacy – chemists
- Regional – larger regional shopping centers
- Employers – larger scale employers main location
- Schools – major primary and secondary schools
- Hospitals – major clinics and hospital sites
- Food Stores – convenience shopping/ local stores
- Cinema – movie houses
- Child Care – site for a child care center or crèche
- Doctors – individual surgeries or clinics
7. Transit Needs Gap Analysis (Cont..)

Supply Modeling

- TransCAD Modelling System
- Each Route coded for 5 time periods:
  - A.M. peak
  - Interpeak
  - Evening
  - Saturday
  - Sunday

<table>
<thead>
<tr>
<th>Element of Travel</th>
<th>Assumptions</th>
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</table>
| Walk Access/Egress Time | • Measured between residential zone centroid and stop or from a stop to the facility destination.  
• Walking is made along the streets of Hobart rather than as the crow flies  
• A walking speed of 4.32 kph is used. A weighting of 2 was applied to walking time to model passenger perceptions of walk quality |
| Fare | • Based on an analysis of revenue and boarding data from the Hobart ticketing system. Included an average fare for travel between zones including higher fares for Hobart coaches routes and also consideration of concession fares for particular passenger groups |
| Wait Time | • Based on half the effective headway of routes operating between on and off stops. Headways based on an analysis of bus schedules.  
• A weighting of 2.0 was applied to wait time to model passenger perceptions of waiting. |
| Value of Time | • Time was valued at $8.69/hour (or 14.48c per minute) based on values used elsewhere in the transit planning industry |
| Transfer Time | • A transfer penalty of 20 minutes was added to the time of those transferring between bus routes |
Transit Service = Calculated generalized costs by area to each of the 14 trip purposes, considering walk time, fare, wait time, value of time and transfer time.

Transit Needs = (0.22*adults without cars) +(0.17*Accessibility) +(0.16*Persons aged over 60 years) +(0.14*Persons on a disability pension) +(0.11*Adults on a low income) +(0.10*Adults not in the labor force) +(0.10*Students)
7. Transit Needs Gap Analysis (Cont..)

Need Score – Low Income
7. Transit Needs Gap Analysis (Cont..)

Need Score – Age 60+
Transit Needs =
(0.22*adults without cars) +
(0.17*Accessibility) +
(0.16*Persons aged over 60 years) +
(0.14*Persons on a disability pension) +
(0.11*Adults on a low income) +
(0.10*Adults not in the labor force) +
(0.10*Students)
7. Transit Needs Gap Analysis (Cont..)

Doctors AM Peak – Costs to Doctors
7. Transit Needs Gap Analysis (Cont..)

AM Peak High Priority Need Gaps

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<th>Rating</th>
<th>Transport Need Rating</th>
<th>Public Transport Quantity/Quality</th>
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<tr>
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<td>Very High Cost</td>
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<td>No Service</td>
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<td></td>
<td>High Need</td>
<td>High Cost</td>
</tr>
<tr>
<td></td>
<td>Mixed Very High/Medium</td>
<td>Mixed Very High/Medium Cost</td>
</tr>
</tbody>
</table>

Less Worst Case
Data for Connectivity + Accessibility Analysis

- **Census**
  - TIGER/Line; Census 2010; American Community Survey; Longitudinal Employment-Household Dynamics (LEHD)
- **Local Data**
  - Household Survey; Employment Data
- **HERE Data**
- **EPA Smart Location Database**
- **Protected Area Database of US (PAD-US)**
- **TOD Database**
- **General Transit Feed Specification (GTFS)**
- **OpenStreetMap**
- **Local Transit network**
- **Google Places**