Jarrett Walker, PhD
JarrettWalker.com
HumanTransit.org
Twitter: @humantransit

Executive Workshop:
TriMet Board of Directors
About Jarrett Walker

- Author *Human Transit* and Humantransit.org.
- 25 years experience in transit network design and policy.
- Projects in >50 metro areas in 9 countries.
- Many successful implementations.
- PhD Humanities.
Why fixed transit?
Ultimately, it’s about Space
Fixed transit is existential for cities

- In dense cities, are those wanting to be dense, transit is existential. *The city is impossible without it.*

- So be careful when anyone tells you that new ideas or technologies are “disrupting” fixed route transit.
No technology will change geometry.

- Energy and Emissions are technology problems.
- But space is a geometry problem.
- Technology never changes geometry.
# Flexible routing = Inefficiency

<table>
<thead>
<tr>
<th>Sample service</th>
<th>Passenger trips/vehicle hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subways in majorcities</td>
<td>&gt;200</td>
</tr>
<tr>
<td>MAX Blue</td>
<td>139</td>
</tr>
<tr>
<td>14-Hawthorne</td>
<td>40</td>
</tr>
<tr>
<td>Infrequent outer suburban/rural circulator</td>
<td>10</td>
</tr>
<tr>
<td>General Public Dial-a-Ride</td>
<td>0-3</td>
</tr>
<tr>
<td>Paratransit (senior-disabled)</td>
<td>0-2</td>
</tr>
<tr>
<td>Uber/Lyft/Taxi</td>
<td>1-3</td>
</tr>
</tbody>
</table>

Supremely effective demand-response can’t get near half the productivity of a very ineffective fixed route!
**Flexible routing = Inefficiency**

<table>
<thead>
<tr>
<th>Sample service</th>
<th>Passenger trips/vehicle hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subways in majorcities</td>
<td>&gt;200</td>
</tr>
<tr>
<td>MAX Blue</td>
<td>139</td>
</tr>
<tr>
<td>14-Hawthorne</td>
<td>40</td>
</tr>
<tr>
<td>Infrequent outer suburban/rural circulator</td>
<td>10</td>
</tr>
<tr>
<td>General Public Dial-a-Ride</td>
<td>0-3</td>
</tr>
<tr>
<td>Paratransit (senior-disabled)</td>
<td>0-2</td>
</tr>
<tr>
<td>Uber/Lyft/Taxi</td>
<td>1-3</td>
</tr>
</tbody>
</table>

How can demand-response service bridge this big gap?
1. Pay driver (much) less.
2. Higher fares.

So replacing fixed route with demand response means:

→ Deepening class divides.
→ Higher congestion, emissions, need for road space.
Roles for demand response

- Service for higher-paying travelers.
  - Logical private sector role.
- *Maybe* transit roles for semi-fixed services doing suburban feeders, but case for subsidy is weak.
  - Still not nearly as productive as a fixed route.

BUT

- Policy needs to capture impacts of these services.
- Probably no reason for TriMet to get into such an inefficient business.
Driverless Cars → Driverless Buses

- Driverless rapid transit already exists.

- Driverless buses are happening (China, Mercedes)

- Labor cost is the biggest limit on transit quantity.

- The driverless bus could make bus service much more abundant.
Will it be different when we have driverless cars?

- **The geometry hasn’t changed.** The efficient use of urban space will still require an attractive, fixed route, big-vehicle system.

Cars with Drivers  
Driverless Cars (partial uptake)  
High-Ridership Bus (Driverless?)
Driverless Cars ➔ Driverless Buses

- Driverless rapid transit already exists.

- Driverless buses are happening (China, Mercedes)

- Labor cost is the biggest limit on transit quantity.

- The driverless bus could make bus service much more abundant.
What is High-Ridership Transit?
To expand ridership, expand freedom (access).

The Wall Around Your Life
Isochrones as maps of your freedom.

How far can Jane travel in 15, 30, 45, or 60 minutes?

Where can I be, now?

Existing Network 2016
Freedom is a geometric fact.
What Maximizes Access?

- High **Frequency** Lines
- Forming a **Connected Network**
- Reasonably **fast and reliable**
- Focused on **Transit Friendly Places**
  - Dense
  - Walkable
  - Linear
  - Proximate
A “map” of the territory we’ll explore.

Abundant Access Handout
A Map of Key Transit Choices

This diagram shows how various value judgments lead toward or away from "Abundant Access". This map is not a recommendation, but an illustration of possible choices.

"Abundant Access"
Access to as many destinations as possible as quickly as possible for the greatest possible number (and diversity) of people. Maximum ridership, maximum fare revenue, and most effective competition with cars.

Human Transit ch. 6
Human Transit ch. 8
Human Transit ch. 10
Human Transit ch. 12

Coverage or Ridership?
Make sure everyone has some service, despite high cost/riders in low-demand areas.
Focus service where ridership potential is high. Offer little service where patronage potential is low.
Run transit very close to every home or destination.
Encourage longer walks to transit and good pedestrian infrastructure.

Peak-only or All Day?
Choose the peak to demand service that supports low cost/riders.
Focus on the peak commute as the most important market.

Civilized or Luxurious?
Define a civilized but not luxurious service that can appeal to the broadest possible spectrum of people.
Focus on high-end transit services for high-end markets.
Focus on direct services with better than office-complex networks.

Connections or Complexity?
Make connections easy through good facilities and frequent bus.

Technology: Tool or Goal?
Define services fitted together as useful network, then select right technology for each service.
Define services in fit for an effective, symbolic impact.

Run transit in areas where congestion is high, making reliable operation impossible.
Give transit a path around making reliable operation impossible.

How far will people walk?
Run transit very close to every home or destination.

“Frequency is freedom!”

Frequency
Frequency comes first

- High frequency means public transport is coming soon. This has three independent benefits:
  - Reduced Waiting
  - Easier Connections
  - Reduced Impact of Disruptions

- Lines with higher frequency tend to have not just higher patronage, but higher patronage per unit of service.
HIGH FREQUENCY ➔ HIGH PRODUCTIVITY

Higher Productivity (Boardings/Hour)

Higher Frequency

15 min  30 min  60 min
TriMet's Frequent Service bus lines and MAX Light Rail run every 15 minutes or better most of the day, every day.
“Over half of all population and jobs will be on the Frequent Network.”
-- Regional Goal 3
Frequent Network Brands

- “Turn up and go.”
- A network for people in a hurry.
- Frequency is Freedom

Vancouver BC

Minneapolis

Bellingham

Los Angeles

Every 15 Minutes (or Less)

Brisbane

Seattle

Spokane
Frequency → Affordability

- Useful enough to be liberating, and

- Abundant enough that it can’t drive up housing prices everywhere.

- Helps build apartments with less parking → affordability
## Bus perceptions vs freq. network

<table>
<thead>
<tr>
<th>Perceptions about “bus”</th>
<th>Frequent Networks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confusing</td>
<td>Simple because of frequency.</td>
</tr>
<tr>
<td>“Easy to change”</td>
<td>Tends toward permanence.</td>
</tr>
<tr>
<td>Noisy, smelly, unpleasant.</td>
<td>Buses can be electric and can be as nice as we want them to be.</td>
</tr>
<tr>
<td>Irrelevant to Land use</td>
<td>Affects location choices and can drive land use modestly, and supports affordability.</td>
</tr>
<tr>
<td>“for disadvantaged people”</td>
<td>Discretionary ridership happens on useful service.</td>
</tr>
<tr>
<td>Unrelated to rail</td>
<td>Builds markets to the point where rail makes sense.</td>
</tr>
</tbody>
</table>
Frequent Network as Co-ordinator

City Government

- Land Use Planning
- Zoning
- Off-St. Parking
- Street Design
- Transit Priority
- Stop Access
- On-St. Parking
- Law Enforcement

The more functions use it, the better it works!

Agreed Frequent Network

Transit Agency

- Service Planning
- Service and Operating Standards
- Marketing
- Public Information
- Capital Priorities

Signals to Private Sector (e.g. Real Estate)
To grow freedom, make connections easy.

Connections

TRIOMET

JARRETT WALKER + ASSOCIATES
In a direct network, nobody needs to connect, but waits are long.
In a connected network, many passengers need to connect, but waits are short.

This network is 5 minutes faster, but in a larger city, the advantage is much greater.
The Genius of the Frequent Grid
Put liberating service where it will liberate the most people.

Where can transit succeed?
# Density

How many people are near transit?

The more people are going to and from the area around each stop, the more people will ride transit.

<table>
<thead>
<tr>
<th>High Ridership</th>
<th>Lower Ridership</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="High Ridership Diagram" /></td>
<td><img src="image2" alt="Lower Ridership Diagram" /></td>
</tr>
</tbody>
</table>
Walkability

Can the people around the stop walk to the stop?

High Ridership

Lower Ridership
Linearity

Can transit run in straight lines that are useful to through-riders?

The straighter the line, the shorter the journey, and the more people can find it useful.
The Ridership-Coverage Tradeoff

But is Ridership What You Want?
Both goals are important, … but they lead opposite directions!

**Ridership Goal**
- “Think like a business.”
- Focus where ridership potential is highest.
- Support dense and walkable development.
- Max. competition with cars
- Maximum VMT reduction

**Coverage Goal**
- “Think like a public service.”
- “Access for all”
- Support low-density development.
- Lifeline access for everyone.
- Service to **every** member city or electoral district.
So it helps to choose a point on the spectrum ...
Linear Presentation ends here. Remaining slides are used as needed, but conversation explores the abundant access diagram.
Case Study of a Ridership-Coverage Conversation: VTA
Current All-day Frequency
So it helps to choose a point on the spectrum ...

Ridership Goal

Coverage Goal

How much should VTA focus on ridership? 70%? 80% 90%?
Please Learn 4 Colors

These will be used consistently throughout the project.

- Rapid. Every 15 min or better and widely spaced stops.
- Every 15 minutes.
- Every 30 minutes.
- Every 60 minutes.

Frequent Network
Current All-day Frequency
Concept 70  (70% Ridership, 30% Coverage)
Concept 80 (80% Ridership, 20% Coverage)

This is not a proposal; it is one of three alternative concepts.

This map shows only light rail and VTA head and rapid bus service. During off-peak, VTA Express, Limited, and Caltrain shuttle services are retained, except where duplicated by other services shown. All Express lines to Fremont are deleted, replaced by BART connections to light rail and local bus at Milpitas and Berryessa Stations.

VTA Route Midday Frequencies:
- Extra Frequent Rapid: Rapid plus every 5 minutes at peak (BART - Diridon)
- Rapid: every 12 minutes or better and limited stops
- Every 15 minutes or better
- Every 30 minutes plus 15 minute peak
- Every 30 minutes
- Every 30 minutes peak only
- Every 60 minutes plus 30 minute peak
- Every 60 minutes
- Every 60 minutes peak only
- VTA light rail
- VTA Transit Center

Other Transit Services:
- Future BART
- Caltrain / ACE commuter rail

Natural area
outside Santa Clara County
Concept 90 (90% Ridership, 10% Coverage)
Access to jobs …

As you move toward a higher ridership network …

- People and jobs near **frequent** transit go up …
- People and jobs near **any** transit go down.

---

**Jobs Accessible by Transit Services**

2016 Network vs. Conceptual Networks 70, 80, 90

(within 1/2 mile of a VTA, Caltrain, or ACE stop in Santa Clara County)

- Frequent Network
- All Day Service - Every 30-60 min.
- Rush Hour Only Service
- No Service

Total Jobs: 976,378
Access by residents …

As you move toward a higher ridership network …
- People and jobs near frequent transit go up …
- People and jobs near any transit go down.

Residents with Access to Transit Services
2016 Network vs. Conceptual Networks 70, 80, 90
(within 1/2 mile of a VTA, Caltrain, or ACE stop in Santa Clara County)

- Frequent Network
- All Day Service - Every 30-60 min.
- Rush Hour Only Service
- No Service

Total Residents: 1,841,569
Visualizing Access

How far can Jane travel in 15, 30, 45, or 60 minutes?

Downtown San Jose
12 noon

Existing Network

Existing Network 2016
Visualizing Access

How far can Jane travel in 15 30 45 or 60 minutes?

Downtown San Jose
12 noon

Concept 70
(70% ridership)
Visualizing Access

How far can Jane travel in 15 30 45 or 60 minutes?

Downtown San Jose
12 noon

Concept 80
(80% ridership)
Visualizing Access

How far can Jane travel in 15, 30, 45 or 60 minutes?

Downtown San Jose
12 noon

Concept 90

(90% ridership)
## So How Many People Is That?

### Residents Accessible by Transit

<table>
<thead>
<tr>
<th>Starting from San Carlos St - S 1st St and traveling for...</th>
<th>30 min</th>
<th>45 min</th>
<th>60 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016 Network</td>
<td>115,200</td>
<td>414,400</td>
<td>816,100</td>
</tr>
<tr>
<td>Increase from 2016 Network</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network 70</td>
<td>4%</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td>Network 80</td>
<td>14%</td>
<td>9%</td>
<td>7%</td>
</tr>
<tr>
<td>Network 90</td>
<td>13%</td>
<td>12%</td>
<td>8%</td>
</tr>
</tbody>
</table>

### Jobs Accessible by Transit

<table>
<thead>
<tr>
<th>Starting from San Carlos St - S 1st St and traveling for...</th>
<th>30 min</th>
<th>45 min</th>
<th>60 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016 Network</td>
<td>118,400</td>
<td>296,300</td>
<td>444,700</td>
</tr>
<tr>
<td>Increase from 2016 Network</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network 70</td>
<td>4%</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>Network 80</td>
<td>8%</td>
<td>11%</td>
<td>7%</td>
</tr>
<tr>
<td>Network 90</td>
<td>8%</td>
<td>11%</td>
<td>8%</td>
</tr>
</tbody>
</table>
Visualizing Access

How far can Jane travel in 15, 30, 45, or 60 minutes?

Mission College
12 noon

Existing Network

Existing-Network 2016
Visualizing Access

How far can Jane travel in 15, 30, 45, or 60 minutes?

Mission College
12 noon

Concept 70

(70% ridership)
Visualizing Access

How far can Jane travel in 15, 30, 45 or 60 minutes?

Mission College
12 noon

Concept 80
(80% ridership)
Visualizing Access

How far can Jane travel in 15, 30, 45, or 60 minutes?

Mission College
12 noon

Concept 90
(90% ridership)
So How Many People Is That?

### Residents Accessible by Transit

Starting from Mission College and traveling for...

<table>
<thead>
<tr>
<th></th>
<th>30 min</th>
<th>45 min</th>
<th>60 min</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2016 Network</strong></td>
<td>13,400</td>
<td>94,300</td>
<td>295,200</td>
</tr>
<tr>
<td>Increase from 2016 Network</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network 70</td>
<td>46%</td>
<td>29%</td>
<td>22%</td>
</tr>
<tr>
<td>Network 80</td>
<td>180%</td>
<td>96%</td>
<td>51%</td>
</tr>
<tr>
<td>Network 90</td>
<td>263%</td>
<td>118%</td>
<td>66%</td>
</tr>
</tbody>
</table>

### Jobs Accessible by Transit

Starting from Mission College and traveling for...

<table>
<thead>
<tr>
<th></th>
<th>30 min</th>
<th>45 min</th>
<th>60 min</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2016 Network</strong></td>
<td>48,300</td>
<td>144,000</td>
<td>333,200</td>
</tr>
<tr>
<td>Increase from 2016 Network</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network 70</td>
<td>29%</td>
<td>41%</td>
<td>22%</td>
</tr>
<tr>
<td>Network 80</td>
<td>72%</td>
<td>59%</td>
<td>31%</td>
</tr>
<tr>
<td>Network 90</td>
<td>100%</td>
<td>76%</td>
<td>43%</td>
</tr>
</tbody>
</table>
Peak Express?
The challenge of peak express

Peak express service imposes three kinds of cost that all day local service does not:

- Inefficiency of short shifts.
- Deadheading against the peak direction.
- Owning, storing, and maintaining fleet that is used only briefly.

Conventional reporting doesn’t highlight these factors, but they are a real reason to resist peak express growth.
Concluding Observations
The Challenge: Plan for Everyone

- High-ridership services attract diverse ridership.
- So all impulses to specialize around certain riders (except paratransit) lead to less efficient design.
- The best network is not what any interest group would design.
- “Market segmentation” can lead us astray if it weighs demographics too heavily.
- Be careful of elite projection.
  - Elite projection = Using your own tastes as a guide to what would make a good service.
Thank you!