Trips, Chains and Tours-- An Operational Definition

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Washington, DC Nov1-2, 2004
Purpose of the Research:

Understanding travel behavior
- Growing understanding that people make travel decisions on multiple destinations

National and local policy initiatives
- Air quality attainment/Fuel Use
- Congestion management: Impact of Flex-Time

Sustainable measure of trends in commute time and length
- Census journey-to-work data does not include regular stops

Trends and growth of non-work travel
- Weekday vs. weekend travel
What is a Trip?

In the NPTS data series a trip is defined as “any travel from one address to another by any means”. 
What is a Trip Chain?

Like art, most transportation planners believe they know a trip chain when they see one.

To set the stage for a common definition, FHWA developed definitions and rules to code trip chains for the 1995 NPTS and the 2001 NHTS.
Currently, most planners incorporate some kinds of trip chains:

- **Traditional (Home-to-Work and Work-to-Home)**
  - **No Limits**
  - **Limit by Time**
    - Limit all stops by one time
  - **Limit by Purpose only**, e.g. serve passenger
    - w/ time
    - w/o time
  - **Limit by a combination of time and purpose**
    - E.g.
      - Serve Pass. – 15 minutes
      - Shop – 30 minutes
      - Exercise - 45 minutes
Tour-based models include more:

Non-Traditional

- Saturday Errands
  Home-Home tours
  w/ more than 1 stop

- Cart the Kids
  (Multiple Serve
  Passenger trips not
  related to work)

- Low-income/immigrant
  communal car-sharing
A few definitions:

- **Anchor**: A primary or substantial trip destination.
- **Direct Trip**: A description of travel without stops between two anchor destinations, such as a trip from home to work.
- **Chain**: A description of a series of short trips linked together between anchor destinations, such as a trip that leaves home, stops to drop a passenger, and continues to work.
- **Intervening Stop**: The stops along a trip chain.
- **Tour**: The total travel between two anchor destinations, such as home and work, whether direct or with intervening stops. Some models refer to ‘complex’ and ‘simple’ tours.
The short story:

The entire trip file was “bundled” by anchor type regardless of number or time at intervening stops:

- Home-Home
- Work-Work
- Home-Work
- Work-Home

The effect on number and type of stops was analyzed for dwell-times of 30, 60, or 90 minutes or less.

A collapsed file was created with 1 record per tour (direct trips and trip chains) with total travel time and miles (POV, transit, walk), number of stops and total dwell-time at all stops, etc.
Step 1. Creating Tours

• Every traveling person’s trips were ‘bundled’ into tours
• Anchors were Home and Work (other included people who never went Home or to Work)
• No dwell time assumptions were made at this point
• All travelers, regardless of age or mode of travel were included:
  • For example, 31 percent of travelers made a home-work tour, but
  • 58 percent of workers made a home-work tour on Travel Day
Trips by Anchor Type
No Dwell Time Rule
n=641,633 trips

<table>
<thead>
<tr>
<th>To</th>
<th>Home</th>
<th>Work</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>From</td>
<td>n=641,633</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home</td>
<td>451,761</td>
<td>59,716</td>
<td>13,442</td>
</tr>
<tr>
<td></td>
<td>70.4%</td>
<td>9.3%</td>
<td>2.1%</td>
</tr>
<tr>
<td>Work</td>
<td>70,113</td>
<td>21,518</td>
<td>932</td>
</tr>
<tr>
<td></td>
<td>10.9%</td>
<td>3.4%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Other</td>
<td>14,098</td>
<td>7,865</td>
<td>2,188</td>
</tr>
<tr>
<td></td>
<td>2.2%</td>
<td>1.2%</td>
<td>0.3%</td>
</tr>
<tr>
<td>To</td>
<td>Home</td>
<td>Work</td>
<td>Other</td>
</tr>
<tr>
<td>----</td>
<td>------</td>
<td>------</td>
<td>-------</td>
</tr>
<tr>
<td>Home</td>
<td>167,244</td>
<td>47,640</td>
<td>6,687</td>
</tr>
<tr>
<td></td>
<td>58.1%</td>
<td>16.5%</td>
<td>2.3%</td>
</tr>
<tr>
<td>Work</td>
<td>47,414</td>
<td>9,817</td>
<td>414</td>
</tr>
<tr>
<td></td>
<td>16.5%</td>
<td>3.4%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Other</td>
<td>4,594</td>
<td>1,756</td>
<td>2,419</td>
</tr>
<tr>
<td></td>
<td>1.6%</td>
<td>0.6%</td>
<td>0.8%</td>
</tr>
</tbody>
</table>
## Mean Stops by Anchor Type

<table>
<thead>
<tr>
<th></th>
<th>To Home</th>
<th>To Work</th>
<th>To Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>From Home</td>
<td>1.7</td>
<td>0.25</td>
<td>1.01</td>
</tr>
<tr>
<td>From Work</td>
<td>0.48</td>
<td>1.19</td>
<td>1.25</td>
</tr>
<tr>
<td>From Other</td>
<td>2.07</td>
<td>0.25</td>
<td>2.25</td>
</tr>
</tbody>
</table>
Step 2. Effect of Dwell Time Rules

1. 90 minutes and less,
2. 60 minutes and less, and
3. 30 minutes and less.

Stepping down the time limits moves more trips into “Other” Tour Types
Effect of Dwell-Time Limits on Tours by Type

- Home-Work
- Work-Home
- Home-Home
- Home-Other
- Other-Home
- Other-Other
- Work-Work

90-Minute
60-Minute
30-Minute
90-Minute Dwell Time at Stops – Home to Work Tours

Dwell Time Minutes

- Median
- Mean
60-Minute Dwell Time at Stops – Home to Work Tours

Dwell Time Minutes

Median Mean

0 10 20 30 40 50 60 70 80 90 100 110 120 130 140

30 Minute Dwell Time at Stops – Home to Work Tours

Dwell Time Minutes

- Median
- Mean

Activities:
- Pick-up
- Drop Off
- Day care
- Buy Services
- Buy Gas
- Fam Personal
- Coffee
- Buy Goods
- Take and wait
- Get Meal
- Prof Srvc
- Visit
- Pub
- Prof Srvc
- Pet Care
- Work Rel
- Med/Dent
- Schl/Ch
- Eat Soc. Evnt
- Soc/Rec
- Non-wrk mtg
- Hang-out
- Library
- Gym/Exercise
- Bus Mtg
90 Minute Dwell Time at Stops – Work to Home Tours

Dwell Time in Minutes

Median Mean

90 Minute Dwell Time at Stops – Work to Home Tours

Dwell Time in Minutes

Median Mean
60 Minute Dwell Time at Stops – Work to Home Tours

Dwell Time in Minutes

Median | Mean

30 Minute Dwell Time at Stops – Work to Home Tours

Dwell Time in Minutes

- Median
- Mean

- Drop Off
- Buy Services
- Buy Gas
- Pick-up
- Coffee
- Fam Personal
- Prof Srvcs
- Buy Goods
- Pet Care
- Take and wait
- Visit Pub
- Get Meal
- Med/Dent
- Pers Srvcs
- Work Rel
- Visit
- Non-wrk mtg
- Schl/Ch
- Soc/Rec
- Library
- Gym/Exercise
- Eat Soc.
- Evnt
- Day care
- Bus Mtg
- Hang-out
Resulting number and percent of trips within tours (30-minute dwell-time rule):

<table>
<thead>
<tr>
<th>To</th>
<th>Home</th>
<th>Work</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>From</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home</td>
<td>121,546</td>
<td>53,492</td>
<td>154,425</td>
</tr>
<tr>
<td></td>
<td>18.9%</td>
<td>8.3%</td>
<td>24.1%</td>
</tr>
<tr>
<td>Work</td>
<td>51,064</td>
<td>11,638</td>
<td>13,571</td>
</tr>
<tr>
<td></td>
<td>8.0%</td>
<td>1.8%</td>
<td>2.1%</td>
</tr>
<tr>
<td>Other</td>
<td>162,060</td>
<td>9,497</td>
<td>64,340</td>
</tr>
<tr>
<td></td>
<td>25.3%</td>
<td>1.5%</td>
<td>10.0%</td>
</tr>
</tbody>
</table>
Step 3. Analyzing Trip Tours with 30 Minutes Dwell Time

- Examine the trends for work travel: How many workers trip chain? Is trip chaining increasing?

- What are the characteristics of workers who trip chain? How are they different from people who make direct trips?

- Why do people stop on their way to work? Is it different on the way home?

- How does tour-level analysis compare with previous assignment of miles to purposes? Have we improved our estimates?
# Trends in the weekday commuting

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Weekday Workers</td>
<td>68,760,000</td>
<td>68,990,000</td>
<td>230,000</td>
<td>0.33%</td>
</tr>
<tr>
<td>Did Not Chain</td>
<td>31,290,000</td>
<td>31,660,000</td>
<td>370,000</td>
<td>1.18%</td>
</tr>
<tr>
<td>Chained Work Trips</td>
<td>17,276,045</td>
<td>18,842,670</td>
<td>1,566,625</td>
<td>9.07%</td>
</tr>
<tr>
<td>Chain Home-to-Work Trip Only</td>
<td>5,929,237</td>
<td>7,158,844</td>
<td>1,229,607</td>
<td><strong>20.74%</strong></td>
</tr>
<tr>
<td>Chain Work-to-Home Trip Only</td>
<td>7,762,956</td>
<td>7,659,436</td>
<td>-103,520</td>
<td><strong>-1.33%</strong></td>
</tr>
<tr>
<td>Chain Both</td>
<td>3,583,852</td>
<td>4,024,390</td>
<td>440,538</td>
<td><strong>12.29%</strong></td>
</tr>
</tbody>
</table>
Not just the incidence but the number of stops is increasing...
We do see some difference by area type...
Workers who make direct trips live closer than those who chain…
(or are people who live farther from work more likely to chain trips during commuting?)
Tour-level analysis captures fewer POV miles overall than previous coding strategies (whytrp90)…

Total POV Miles for Work, 16+

- Whytrp90-1995
- Whytrp90-2001
- Tour level-1995
- Tour level-2001
However, transit miles are captured better…

Total Transit Miles for Work, 16+

- Whytrp90-1995
- Whytrp90-2001
- Tour level-1995
- Tour level-2001
And walk miles about the same...

Total Walk Miles for Work, 16+

The effect of trip-chaining on travel mode needs further research...

<table>
<thead>
<tr>
<th></th>
<th>POV</th>
<th>Transit</th>
<th>Walk/Bike</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct Trip</strong></td>
<td>83.7</td>
<td>6.3</td>
<td>2.9</td>
<td>7.1</td>
</tr>
<tr>
<td><strong>Home-Work Chain</strong></td>
<td>88.1</td>
<td>3.4</td>
<td>1.1</td>
<td>7.5</td>
</tr>
<tr>
<td><strong>Work-Home Chain</strong></td>
<td>87.9</td>
<td>3.7</td>
<td>1.9</td>
<td>6.6</td>
</tr>
<tr>
<td><strong>Chain Both Directions</strong></td>
<td>90.7</td>
<td>3.5</td>
<td>0.6</td>
<td>5.2</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>86.1</td>
<td>4.0</td>
<td>2.2</td>
<td>7.7</td>
</tr>
</tbody>
</table>
We can measure the changes in miles and minutes of travel to work separately from the trends in chaining...

Difference in Miles and Minutes in Commuting

<table>
<thead>
<tr>
<th>Tours with Stops</th>
<th>2001</th>
<th>1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Trips</td>
<td>2001</td>
<td>1995</td>
</tr>
</tbody>
</table>

- **Person Miles**
- **Person Minutes**
And look at the purpose of incidental stops during the commute by tour type (weekday work tours)

- Fam/Pers
- Shop
- Gas
- Soc/Rec
- Serv Pass
- Meal/Coff

Bar chart showing the percentage of stops for each purpose, with categories like Home-to-Work and Work-to-Home.
Non-work tour analysis is still in research infancy...

<table>
<thead>
<tr>
<th>Total Person Miles in Non-Work Tours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday</td>
</tr>
<tr>
<td>1995</td>
</tr>
<tr>
<td>Person Miles (000,000)</td>
</tr>
<tr>
<td>8,000,000</td>
</tr>
</tbody>
</table>

![Bar chart showing total person miles in non-work tours for weekday and weekend in 1995 and 2001.](chart.png)
Conclusions

• This operational definition allows comparison of travel behavior over time and between areas, especially as a consistent measure of commute miles and minutes.

• Trip chaining is a growing phenomenon, especially in the commute to work, perhaps related to greater distances between home and work.
  – Research into the trends in job/residence location, especially for 2-worker families, would be illuminating.

• Home-based tours show surprising growth on weekdays, and women make a greater percent of home-based tours than men.
  – Further research into non-work travel is needed.

• Files are available for researchers and planners – let us know what you discover!
Trip Chaining Differences Between Men and Women
1995-2001 NPTS/NHTS data series

Nancy McGuckin, Travel Behavior Analyst and
Yuki Nakamot, SAS Programmer

Research on Women’s Issues in Transportation
Chicago, Illinois Nov. 18-20
Women...

- Of working age travel more of their miles in non-work tours than men
- Work nearly 3 miles closer to home than men, regardless of occupation
- Pick-up and/or drop-off children on their way to and from work, even in 2-worker families
- Chain other trips into their commutes more often than men, and this varies by race/ethnicity and purpose of the stops
Men...

- Have increased their trip chaining in commute tours almost twice women’s increase since 1995 (11.6 vs. 6.3 percent change)
- Who are in families with 2 adults and small children have increased trip chaining more than other groups
- Who trip chain have added stops in the home-to-work direction

P.S. There’s a surprise ending
Overall, women (16-65 years old) travel more in non-work tours than men:
Men have increased trip chaining in commute tours at nearly twice the pace of women since 1995...
No matter what occupation, women work closer to home...
Women with children work closer to home than their male counterparts...
Maybe because even in 2-worker families, women are more likely to pick-up/drop off kids at school…
And they have to be on time…
Women in 2-adult families have increased their trip chaining...

Percent of Women who Trip Chain by Lifecycle, 1995 and 2001

- 2+adlt, child16-21
- 2+adlt, child 6-15
- 2+adlt, child<5
- 2+adlt, 0 child

Percent

0 0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5

1995 Women 2001 Women
But men have increased more, esp. in families with small children…
The purpose of stops differs by gender…

Home-to-Work Stops by Selected Purpose

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Men 2001</th>
<th>Women 2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shop</td>
<td>20.0%</td>
<td>10.0%</td>
</tr>
<tr>
<td>Fam/Pers</td>
<td>30.0%</td>
<td>15.0%</td>
</tr>
<tr>
<td>Serv Pass</td>
<td>40.0%</td>
<td>50.0%</td>
</tr>
<tr>
<td>SocRec</td>
<td>10.0%</td>
<td>10.0%</td>
</tr>
<tr>
<td>Meal/Coffee</td>
<td>10.0%</td>
<td>15.0%</td>
</tr>
</tbody>
</table>
And by direction…

Work-to-Home Stops for Selected Purposes

- Shop
- Fam/Pers
- Serv Pass
- Soc.Rec
- Meal/Coffee

Men 2001
Women 2001
There is variation in trip chaining by race and ethnicity...

Percent of Stoppers by Sex and Race

- **White**
- **Hisp**
- **Afr-Am**

Bar chart showing the percentage of stoppers by sex and race.
And by Race/Ethnicity within Purpose....


-15 -10 -5 0 5 10 15 20 25

Afr-Am
Hisp
White

Percent Change 1995-2001
Stops for meals and/or coffee increased pretty dramatically between 1995 and 2001...
We call this the “Starbucks” effect

Make mine a venti!