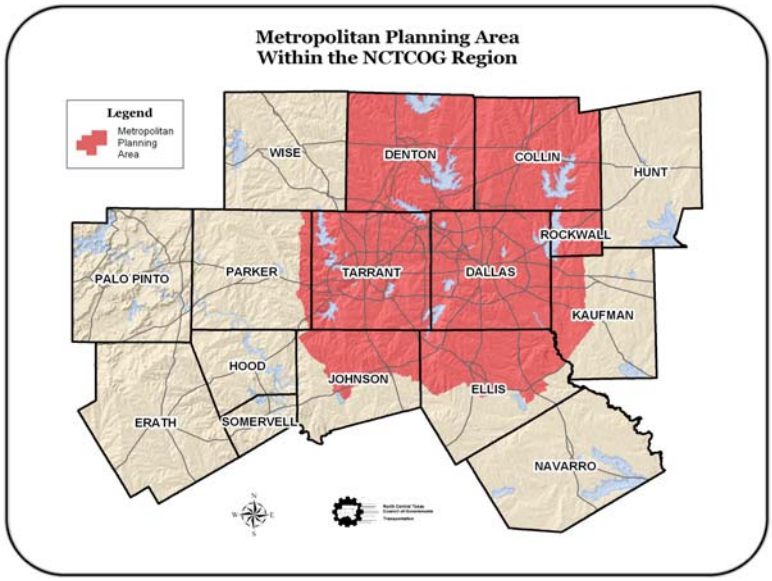
Travel Demand Modeling At NCTCOG

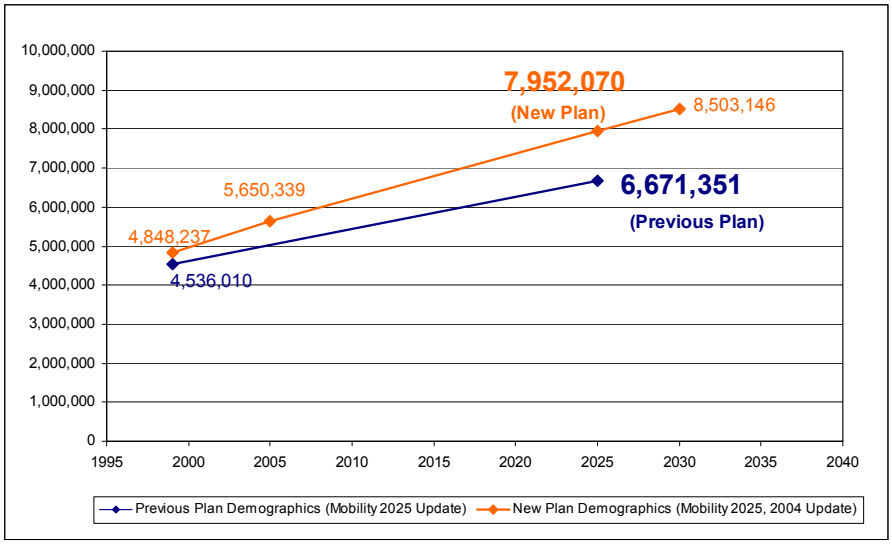
Presentation For
IOWA TMIP Peer Review
March 30 – April 1, 2004

Agenda

- Background
- DFW Regional Model Structure
- Traffic Assignment
- Calibration/Validation Issues
- Texas Statewide Analysis Model
- Next Steps



Total Population Within The Dallas – Fort Worth Metropolitan Planning Area



NCTCOG Departments (9)

Executive Director's Office
Agency Administration
Community Services
Emergency Preparedness
Environment And Development
Public Affairs
Research And Information Resources
Transportation (Also Serves As The MPO)
Workforce Development

Transportation Department Program Areas (6)

Administration (Michael Morris And Dan Kessler)

Air Quality Planning And Operations (Chris Klaus)

Information Systems (Ken Cervenka)

Strategic Initiatives And Community Outreach (Mike Sims)

Transportation Planning (Dan Lamers)

Transportation Programming And Operations (Dan Rocha)

Information Systems

Transportation Data Management (Including Web-Based Activities And GIS Support)

Vehicle Operations (e.g., Traffic Simulation)

Development, Maintenance, And Support Of Travel Demand Forecasting Tools

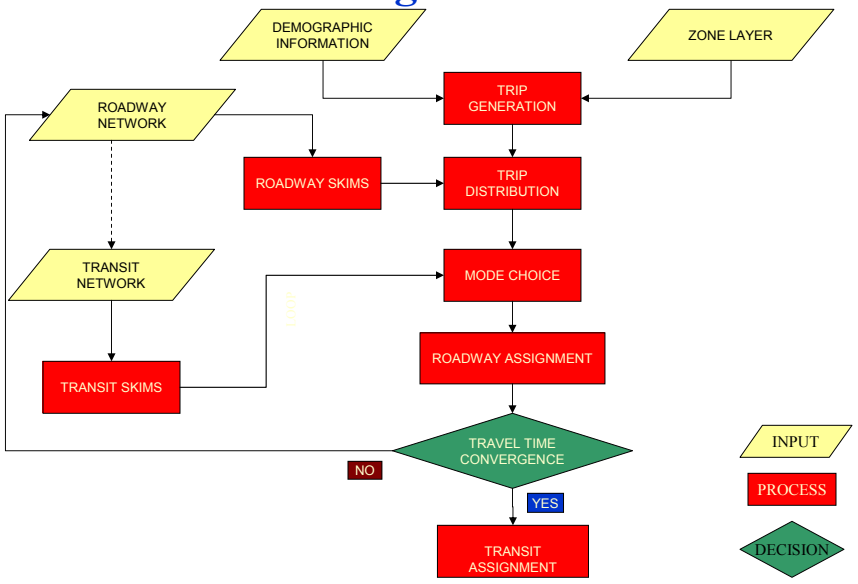
Modeling Environment

NCTCOG-Developed FORTRAN Programs (Mainframe)
- MOBILE5A Emissions Analysis
- Latest Mobility Plan Update (Last Year)
- For Legacy Applications

TRANPLAN (PC)
- Subarea Traffic Modeling (Legacy Applications)

TransCAD (PC-Windows)
- MOBILE6 Emissions Analysis
- Future 2030 Mobility Plan
- All New Travel Modeling Activities

Four-Step TRANSCAD Modeling Process

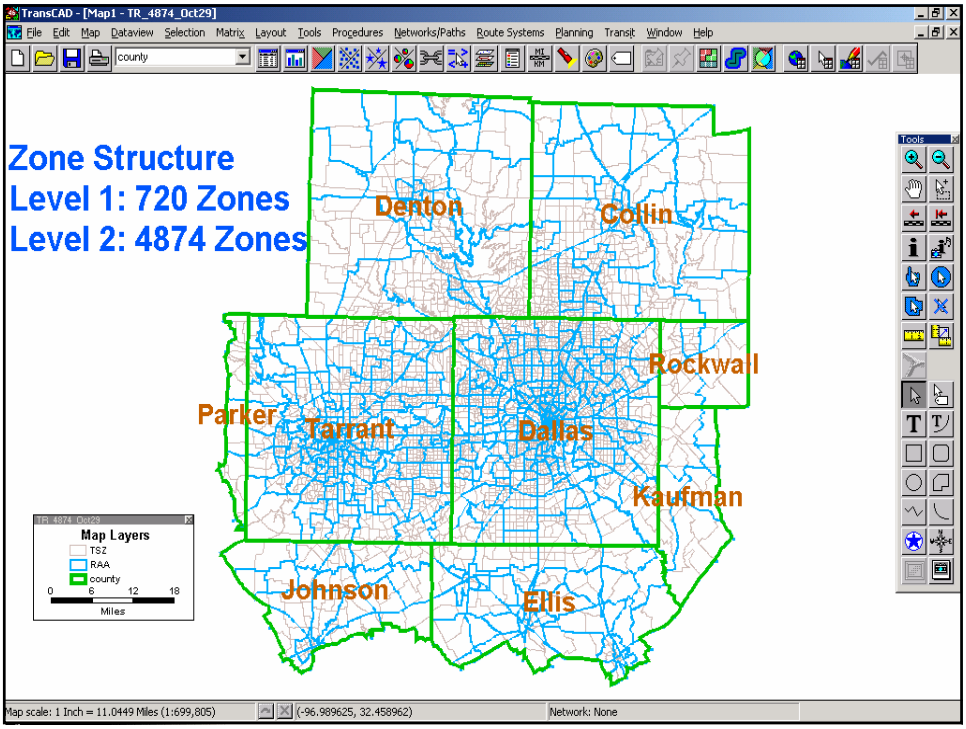


TRANSCAD Model Size

4874 Zones Retained For ALL Modeling Steps
- From Trip Generation To Traffic/Transit Assignment
- 4813 Internal + 61 External
- Number Of Zone-To-Zone Pairs = 23.8 Million

Year 2025: 27,000 Roadway Links
+ 9,600 Zone Connectors
- Over 36,000 Coded Links
- 22,000 Network Nodes

2025 Transit
- 410 Coded One-Way Bus Lines And 36 Rail Lines
- 14,500 Bus Stops And 171 Rail Stations

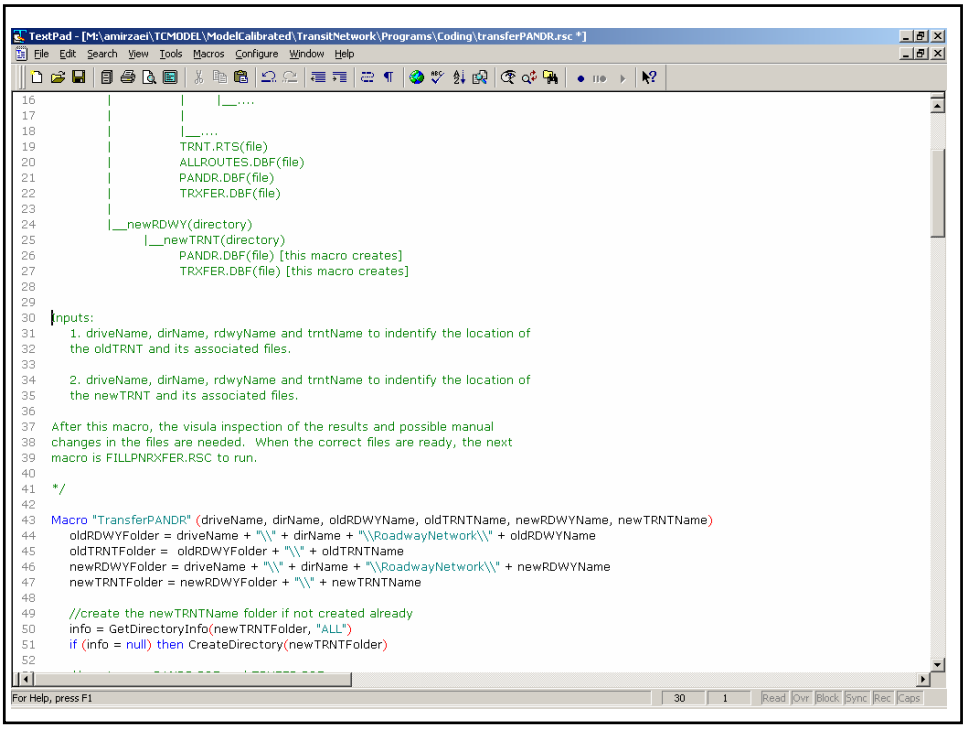


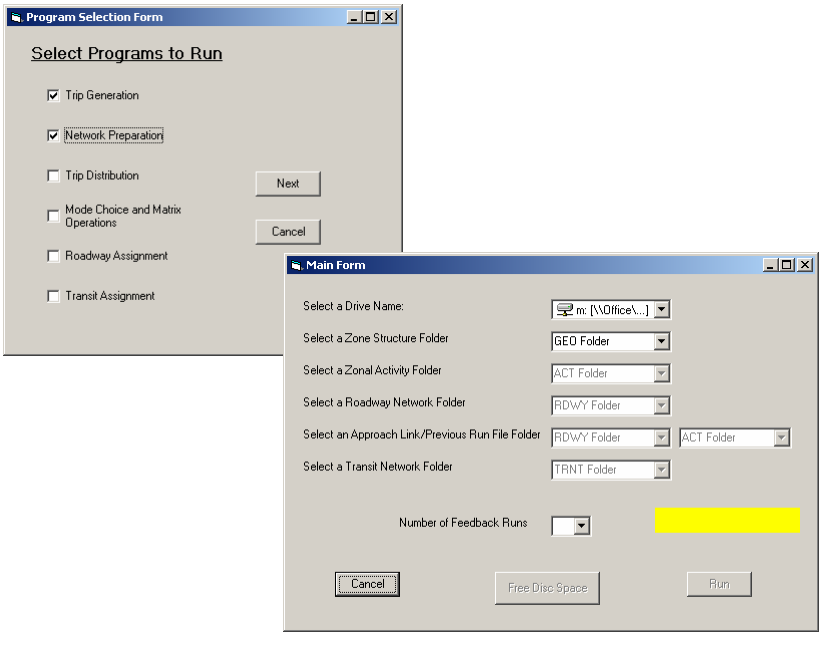
Transition To Reality

Actual Scope Of Human Behavior → Model Scope

- **All Person Trips → Motorized Person Trips**
- **All Travel Purposes → HBW, HNW, NHB, And Truck Purpose Categories**
- **All Occupations → Basic, Retail, And Service Jobs**
- **All Households → Income And Household Size Categories (Plus Auto Ownership Breakdowns)**
- **All Streets → Non-Local Streets**

Individual Data → Aggregate Data (Zones)

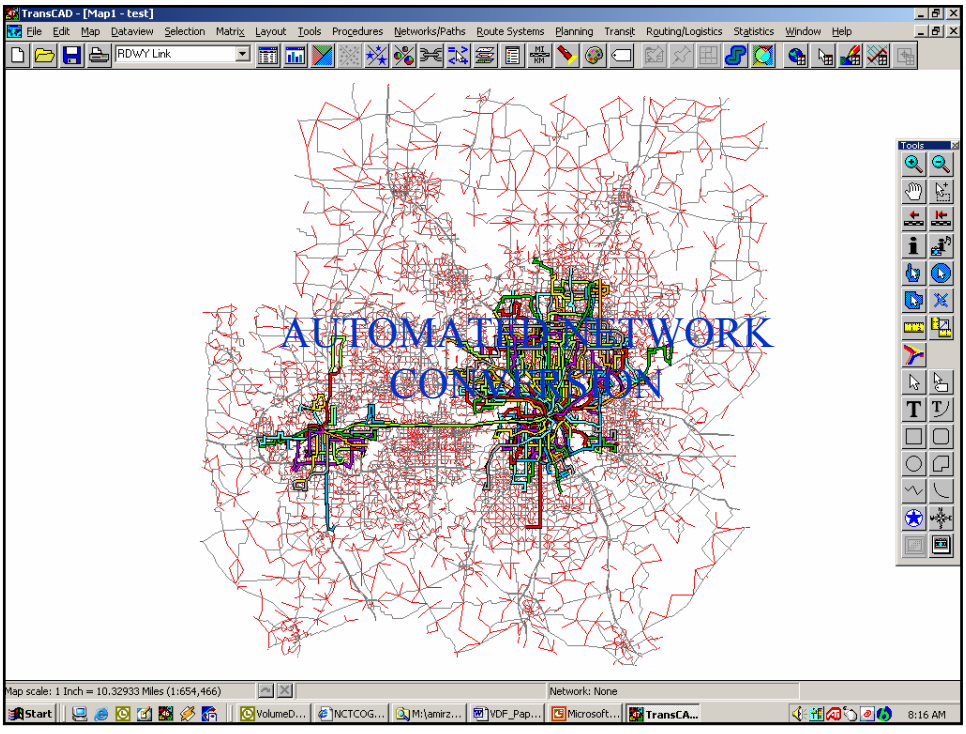

TextPad - [M:\amirzaei\TCMODEL\ModelCalibrated\TransitNetwork\Programs\Coding\transferPANDR.rsc *]
File Edit Search View Tools Macros Configure Window Help
| |__....
| |
|__....
TRNT.RTS(file)
ALLROUTES.DBF(file)
PANDR.DBF(file)
TRXFER.DBF(file)
|__newRDWY(directory)
|__newTRNT(directory)
PANDR.DBF(file) [this macro creates]
TRXFER.DBF(file) [this macro creates]
Inputs:
1. driveName, dirName, rdwyName and trntName to indentify the location of
the oldTRNT and its associated files.
2. driveName, dirName, rdwyName and trntName to indentify the location of
the newTRNT and its associated files.
After this macro, the visula inspection of the results and possible manual
changes in the files are needed. When the correct files are ready, the next
macro is FILLPNRXFER.RSC to run.
*/
Macro "TransferPANDR" (driveName, dirName, oldRDWYName, oldTRNTName, newRDWYName, newTRNTName)
oldRDWYFolder = driveName + "\\" + dirName + "\\RoadwayNetwork\\" + oldRDWYName
oldTRNTFolder = oldRDWYFolder + "\\" + oldTRNTName
newRDWYFolder = driveName + "\\" + dirName + "\\RoadwayNetwork\\" + newRDWYName
newTRNTFolder = newRDWYFolder + "\\" + newTRNTName
//create the newTRNTName folder if not created already
info = GetDirectoryInfo(newTRNTFolder, "ALL")
if (info = null) then CreateDirectory(newTRNTFolder)
For Help, press F1
30
1
Read Ovr Block Sync Rec Caps


Program Selection Form
Select Programs to Run
Trip Generation
Network Preparation
Trip Distribution
Mode Choice and Matrix Operations
Roadway Assignment
Transit Assignment
Next
Cancel
Main Form
Select a Drive Name:
m: [\\Office\...]
Select a Zone Structure Folder
GEO Folder
Select a Zonal Activity Folder
ACT Folder
Select a Roadway Network Folder
RDWY Folder
Select an Approach Link/Previous Run File Folder
RDWY Folder
ACT Folder
Select a Transit Network Folder
TRNT Folder
Number of Feedback Runs
Cancel
Free Disc Space
Run

Model Run Times
(For 3.2 GHz PC)

Full "No Feedback" Model Run = 647 Minutes (10.8 Hours)

- Trip Generation = 1.0 minute
- Roadway Skimming (4) = 11 minutes
- Trip Distribution = 11 minutes
- Market Segmentation = 6 minutes
- Transit Prep And Skimming (4) = 77 minutes
- Mode Choice (13) = 65 minutes
- Matrix Preparations (For Transit Assignment) = 10 minutes
- Transit Assignment (4) = 21 minutes
- Matrix Preparations (For Traffic Assignment) = 98 minutes
- Traffic Assignment (3) = 347 minutes (5.8 hours)



Roadway Preparation

Link Free Speed (Based On Speed Limit, Distance, Area Type, Functional Class, And Intersection Control)

Directional Hourly Capacity (Based On Lanes, Area Type, Functional Class, And Divided/Undivided Designation)

Time Period Capacity

AM Peak, PM Peak, And OffPeak

Trip Generation

GISDK Macro Language

Seven "Regular" Internal-Internal Trip Purposes

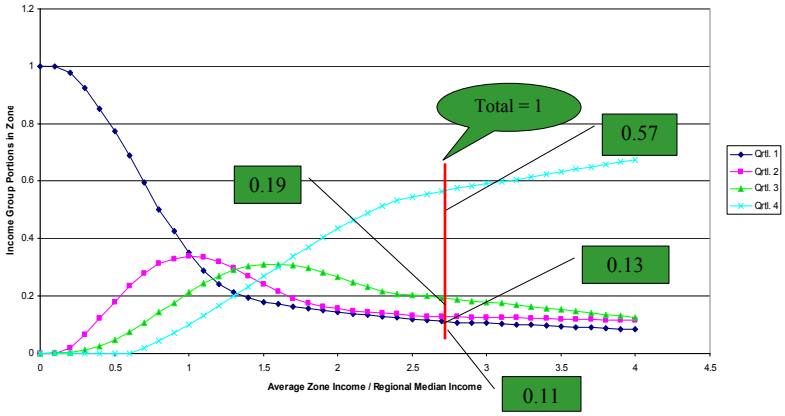
4 HBW, 1 HNW, 1 NHB, And 1 Truck

Inputs

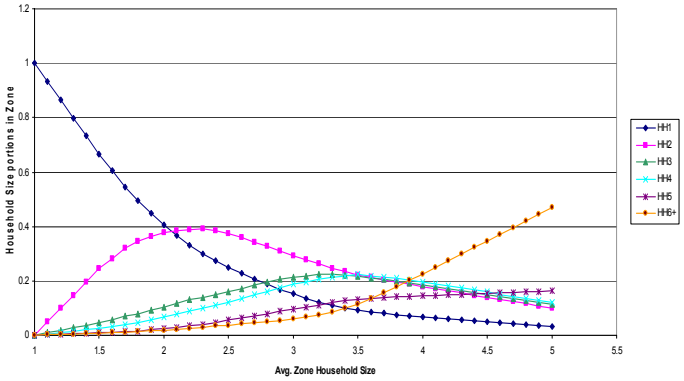
Population, Households, Income, And Basic/Retail/Service Jobs

Special Generators (Shopping Malls, Colleges, Hospitals, Airports)

Household Income Distribution



Household Size Distribution



Demographics For Special Generators

Current Special Generators

- Regional Shopping Malls With Over 500,000 Square Feet (20)
- Colleges/Universities With Over 1,500 Enrolled Students (27)
- Hospitals With Over 300 Service Employees (42)
- DFW And Love Field Airport Terminals (Special Treatment)

Special Input Data Fields (e.g., For Shopping Malls)

- SGRETAIL = Number of Jobs In Zone That Relate To The Shopping Mall
- SGUNIT = Total Leasable Square Footage (Thousands Of Square Feet)
- HBW, HNW, NHB, And Truck Trip Rates Per Thousand Square Feet

External Station Trip Tables

Internal-External And External-Internal (IE/EI) Weekday Passenger Vehicles (Total Trip Ends)

External-External (EE) Weekday Passenger Vehicles

IE/EI Weekday Trucks (Six Or More Tires)

EE Weekday Trucks (Six Or More Tires)

Trip Distribution

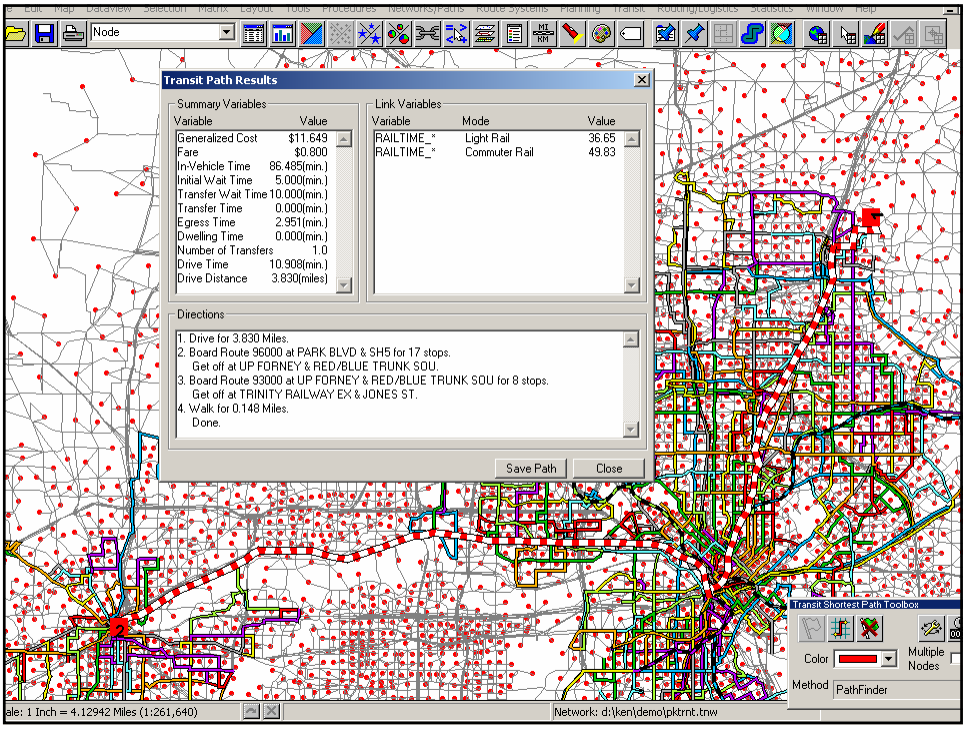
Gamma-Format Gravity Model (7 Purposes)
- Four HBW Groups (Income Quartiles) – AM Peak Skims
- HNW (Non-Airport) -- OffPeak
- NHB (Non-Airport) -- OffPeak
- Trucks (Vehicles With Six Or More Tires) -- OffPeak

Base Year Trip Table Factoring (6 Purposes)
- HNW And NHB Airport Trips
- Four External-Related Auto/Truck Trips

Zone To Zone Skim Tables For Mode Choice

Four AM Peak Skims (6:30a – 8:59a)
- Roadway – Without HOV Links Available (Drive Alone)
- Roadway – With HOV Links Available (Shared Ride 2 And 3+)
- Transit – Drive Access (PA Format)
- Transit – Walk Access (PA Format)

Four OffPeak Skims
- Roadway Is 18-hour Offpeak
  - Without HOV Links Available (Drive Alone)
  - With HOV Links Available (Shared Ride 2 And 3+)
- Transit Is 6-hour Mid-Day Offpeak (9:00a – 2:59p)
  - Drive Access (PA Format)
  - Walk Access (PA Format)



Mode Choice Inputs

Auto Travel

- Roadway Travel Time
- Roadway Length (Operating Cost)
- Daily Parking Cost

Transit Travel

- In-Vehicle Transit Travel Time (Includes Dwell)
- Walk (Or Drive) Access Time
- Walk Transfer And Egress Time
- Initial And Transfer Wait Time
- Transit Fare
- Market Segment And Area Type Constants

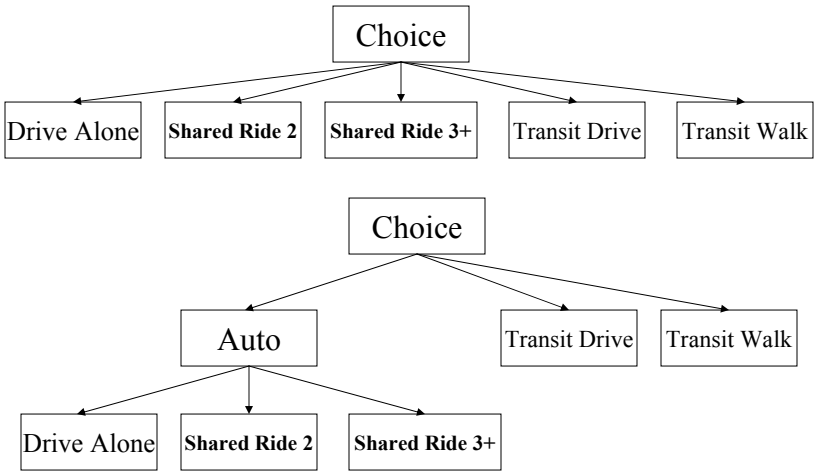
Market Segmentation

Objective: To Account For Differences In Commuter Behavior

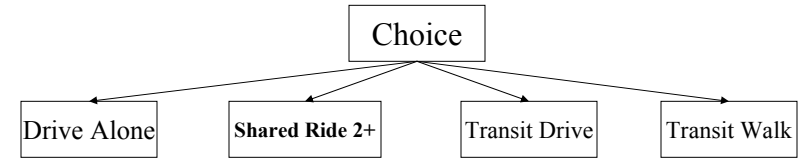
Segmentation Basis (6 HBW And 6 HNW)

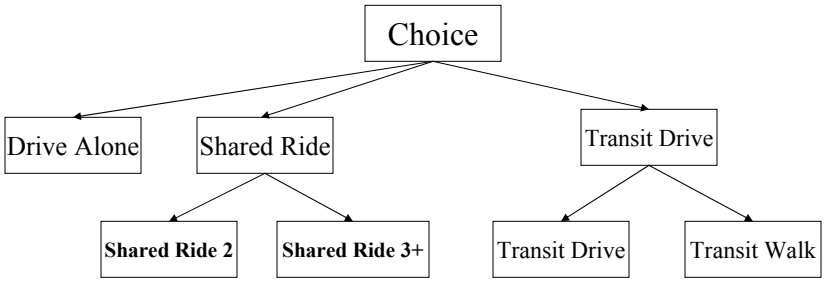
- **Household Income (3)**
  - **Low**
  - **Medium**
  - **High**
- **Vehicle Availability For A Household (2)**
  - **Vehicles Less Than Persons**
  - **Vehicles Greater Than Or Equal To Persons**

HBW Mode Choice: Mainframe vs. TRANSCAD

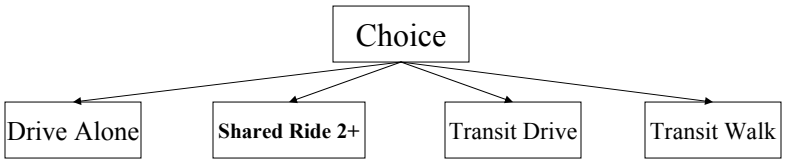


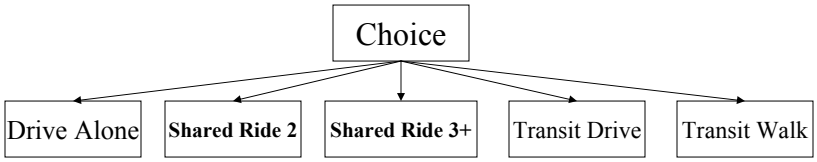
HNW Mode Choice: Mainframe vs. TRANSCAD





NHB Mode Choice: Mainframe vs. TRANSCAD





Transit Assignment

Four Multi-Path (Pathfinder) Production-Attraction Assignments

For All HBW Transit Trips
- Peak Transit-Initial Drive Access (Park-and-Ride)
- Peak Transit-Initial Walk Access (No Park-and-Ride)

For All HNW And NHB Transit Trips
- Offpeak Transit-Initial Drive Access (Park-and-Ride)
- Offpeak Transit-Initial Walk Access (No Park-and-Ride)

Traffic Assignment Preparation

PA To OD Trip Table Transposing, Time-Of-Day Factoring, And Aggregation Of Trip Purposes
- AM Peak Period (2.5 Hours)
- PM Peak Period (3.5 Hours)
- Off Peak Period (18 Hours)

K Factoring Of OD Trip Tables (Post Mode Choice)
- Compensate For Gravity Model Limitations
- OD Estimation Procedure To Help With Problem Identification
- Adjustments/Checks Based On Screenline Results

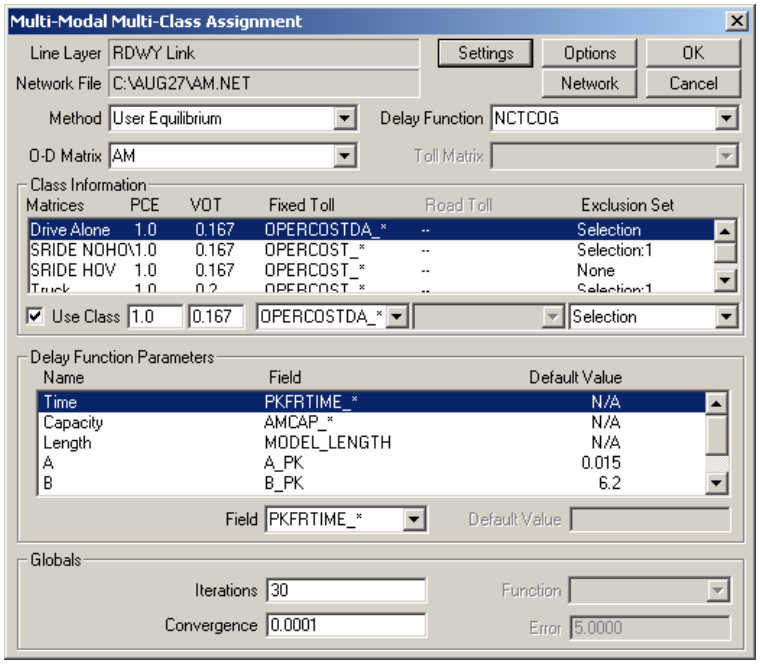
Traffic Assignment

User Equilibrium Generalized Cost (Three 30-Iteration Assignments)

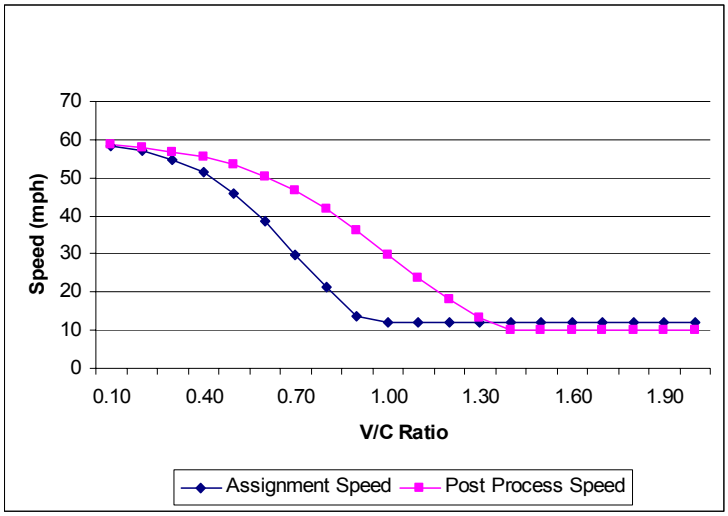
- A.M. Peak (6:30a – 8:59a: 2.5 hours)
- P.M. Peak (3:00p – 6:29p: 3.5 hours)
- OffPeak (18 hours)

Four Vehicle Classes Loaded Simultaneously

- Drive Alone
- Shared-Ride "Sees" HOV Lanes
- Shared-Ride "Doesn't See" HOV Lanes
- Trucks (Vehicles With 6 Or More Tires)



Speed vs. V/C Ratio (Example)



Post-Processing Of Link Speeds

Example: AM Peak Directional Link Speeds

Allocate (Based on Observed Time-Of-Day Factors) The 2.5-Hour AM Peak Assignment Volume Into Three Sub-Periods
- **6:30a – 6:59a (30 Minutes)**
- **7:00a – 7:59a (60 Minutes)**
- **8:00a – 9:00a (60 Minutes)**

Calculate V/C ratios For Each Sub-Period
- **Note: Capacity for 30-minute period is ½ the hourly capacity**

Apply The "Post Process" Volume Delay Curves

Traffic Model Limitations

Ideally, the peak and offpeak congested speeds directly from traffic assignment should be used in trip distribution—but we "post process" because the assignment-calibrated parameters do not give us realistic speeds

Related to above: "Peak Spreading" is not directly considered; in the future, we may consider peak hour and "shoulder of the peak" assignments

We have no observed data to directly calibrate HOV-Toll usage; instead, we have to rely on our separately-calibrated HOV modeling and "toll road value of time" modeling

Traffic Model Limitations (Cont.)

The Offpeak assignment represents 18 hours of the day—perhaps a future breakdown into Mid-Day Offpeak (9:00 a.m. – 2:59 p.m.) and Evening/Night Offpeak (6:30 p.m. to 6:29 a.m.)

All passenger vehicles are assumed to have the same value of time

Calibration/Validation Issues (Transit)

Reasonableness Of Peak and Offpeak Transit Speeds Used In Skimming For Mode Choice (Observed And Future)

Coded vs. Observed Bus And Train VMT

Modeled vs. Observed Weekday Riders By Bus Route And Rail Route (Route-Level RMSE And Percent Error)

Modeled vs. Observed Weekday Rail Station Boardings (Station-Level RMSE And Percent Error)

Reasonableness Of Modeled vs. Observed Mode Of Access Distributions To Individual Rail Stations

Calibration/Validation Issues (Traffic--Slide 1)

Current And Future-Year Reasonableness Of Roadway Speeds Used In Skimming For Trip Distribution And Mode Choice

Reasonableness Of Modeled vs. Observed Percent Intrazonal Trips By Trip Purpose (DFW = 1.5% For HBW; 8.7% For HNW; 9.3% For NHB; And 0.5% For Trucks)

Reasonableness Of Modeled vs. Observed Average Person Trip Lengths (Or Trip Length Frequency Distributions) By Trip Purpose, For Interzonal Trips

Modeled vs. Observed Weekday Link Volumes By Functional Class (RMSE And Percent Error)

Calibration/Validation Issues (Traffic—Slide 2)

Modeled vs. Observed Weekday Screenline Volumes (Overall Magnitude And % Error); DFW = 1262 Links On 89 Screenlines

Modeled vs. Observed AM Peak, PM Peak, And OffPeak Auto And Truck VMT By Functional Class (% Error)

Check Very High And Very Low AM, PM, And OffPeak V/C Ratios

Checks Of The "Hundred Largest Link Errors" Report
- Magnitude And % Error

Calibration/Validation Issues (Traffic—Slide 3)

"True" Validation Requires Calibration Sensitivity Tests AND Forecast Sensitivity (Or Sensibility?) Tests

Calibrated Model "Backcast" Checks Would Be Nice, Although Historical Model Validity Is Still No Guarantee Of Forecastability

Individual Capacity-Per-Lane Changes To Improve Validation?
- No, But Consider More Functional Classes
- Keep In Mind The Prime Objectives For Modeling
- Link-Specific Changes Are Problematic For New Links

Calibration/Validation Issues (Traffic—Slide 4)

Individual Link Speed/Impedance Changes To Improve Validation?
- No, But Check Speed Limits And Functional Class
- Check Reasonableness Of Free And Congested Speeds
- Try To Find The Underlying Cause

Change Centroid Connectors To Improve Validation?
- Sure (But Apply Modifications In Some Logical Manner)
- Don't Forget "Forecastability" Of The Connectors
- Caution On Zone Sizes

Factor Trip Tables To Improve Screenline Validation Results?
- Yes—But Exercise Due Caution On Forecastability
- Not Theoretically Elegant!
- Check First For Trip Generation Problems

The Texas Statewide Analysis Model

Covers Entire State, Plus "Buffer" Counties
- 4,742 Model Zones
- 1998 Calibration/Validation (19.8 Million People In State)
- 2025 Forecast (31.2 Million People)

Single Multi-Year Coded Network
- Each Record Contains Separate Link Attributes For 1998 And 2025 (Lanes, Speed Limit, Estimated Congested Time, Capacity)

The Texas Statewide Analysis Model – Trip Types

Passenger Travel
- Vehicle Trips By Auto
- Person Trips By Air
- Person Trips By Rail (AMTRAK)
- Placeholder For High-Speed Rail

Freight Travel
- Commodities By Truck
- Commodities By Rail
- Commodities By Water

The Texas Statewide Analysis Model: Potential NCTCOG Uses

Use Forecast Traffic Volumes For Our External Stations

Traffic Studies In Areas Outside Our 5,000 Square-Mile Urban Model (But Within Our 16-County NCTCOG Area)
- e.g., Parker County Thoroughfare Plan

Commodity Flow Studies/Freight Bottleneck Studies

What Happens Next For NCTCOG

Training Of "TransCAD Model Application Champions"
- NCTCOG Staff
- DART Transit Staff
- Other Agencies (???)
- Certification Of Consultants (???)

Prepare Additional Roadway/Transit "Supply And Demand" Performance Reports

Model Documentation
- Include The "What" As Well As The "Why" Of What We Now Have

What Happens Next (Cont.)

Greater Focus On The Underlying Information System

Improvements/Updates To Modeling Procedures
- LOGSUM Consistencies
- Destination Choice Instead Of Gravity Model Trip Distribution
- Expansion Of Modeled Area
- Sensitivity Tests Of Person Tour (e.g., Activity-Based) Models
- New Travel Surveys In 2006

Coordination With TxDOT Statewide Analysis Model

Traffic Microsimulation For Operations Analysis

Recommendations For Model Applications Work At NCTCOG

Every Modeling Study Needs "Direct Oversight" By A TransCAD Model Applications Champion -- So, What Is A Champion?

Has A Good Understanding Of GIS And Travel Model Theory

- **Maybe We Should Give An Oral Certification Test!**

Is Very "Hands-On" Experienced With TransCAD

- **We Can Test People On This, Too!**

…And (Ideally) Spends Over 70% Of His/Her Time On Model Applications Work