12 – Early Quality-of-Service Analysis of the Alternatives

- Design of service plans
- Early understanding of the alternatives
- Better communications with FTA
Motivations

• Experience over the past four years
  – Limited insights from review of service plans for the alternatives
  – Real insights from analytical reporting of forecasts – thematic maps, D-D tables
  – So, FTA does not “approve” alternatives – especially the TSM alternative – based on early definitions
Motivations

• Early discussion still important
  – Sponsors want reassurance
  – FTA wants to avoid late disagreements

• Early analysis of service plans is highly desirable
  – Enough to understand service implications
  – And to permit agreement on the strategic service plan for each alternative
Principles for Alternatives Design

- Address purpose and need
- Include baseline options
- Include all reasonable modes and alignments
- Encompass an appropriate range of options without major gaps in costs
- Include:
  - Alternatives addressing different goals
  - Alternatives have a reasonable chance of becoming the locally preferred alternative (LPA)
Principles for Alternatives Design

Since all alternatives should address the same purpose and need:

All alternatives should strive to provide enhanced quality of service to the same markets
Alternatives Definition

- Three stages
  - Conceptual
  - Detailed
  - Final
- Each describes with increasing detail
  - Technology
  - Alignment
  - Operating Plan
Conceptual Alternatives

- Operating plans are strategic; for example:
  - LRT with park-ride
  - Express buses on separate guideway with stations
  - Express bus on freeway; park-ride but no stations
  - Limited stop service on arterial + signal preemption
  - High frequency local service

- FTA wants to talk about the concepts and the strategic service plans
Detailed Alternatives

• Operating plans sufficient to support network coding and O&M cost analysis
Final Alternatives

• Reflects analysis and refinement of detailed alternatives to demonstrate:
  – Responsiveness to purpose and need
  – Consistency with markets served by the build alternative
  – Cost-effective relative to the no-build

• Baseline
  – Approved by FTA only after project sponsor completes detailed analysis
Quality of Service Analysis

- Systematic approach to understanding how each alternative serves the intended markets
- Review of route maps and tables of frequencies for consistency is important, but not sufficient
- Need to understand the interaction between the travel model and the service plan
Some Basic Issues

- Route structure
- Span of service (days and hours)
- Fare structure
- Park-ride locations, capacities and access
An Approach to QOS Analysis

• Develop networks early in the analysis
  – For both Build and possible Baseline alternatives

• Use your travel models
  – Networks and pathbuilder, at least
  – And mode choice?
  – And user-benefits calculations?
Early QOS Analysis

Urbanville

- >5 mins worse
- <5 mins worse
- 0 mins
- 1 to 5 mins
- 6 to 10 mins
- 11 to 15 mins
- 15+ mins

5 miles

June 2006
An Approach to QOS Analysis (continued)

- Develop some type of forecast year transit trip table
  - From previous analysis
  - From model application for one network
  - Use person trip table if nothing else available

- Use the tools you have to examine
  - Trip table differences
  - Skim table differences
  - Summit can assist but is not required at this stage

- Use GIS to assist in analysis
An Approach to QOS Analysis (continued)

• Examine differences in:
  – Coverage
  – Fares
  – Travel time (weighted and unweighted)
  – Park-ride service areas
  – Number of transfers
An Approach to QOS Analysis (continued)

- Look for:
  - Areas where service is reduced in a proposed TSM alternative compared to the No-Build
  - Areas where service is reduced in the Build alternative compared to a TSM alternative
  - Significant changes in the QOS for markets not directly served by the proposed project
Barriers?

- How much of this is being done early?
- If not much, what prevents it?
  - Working on models?
  - Operating plans not really defined?
  - Holding information closely?
- How about early application of full models to get previews?
- Anything that FTA should do?
13 – Dealing with Uncertainties in New Starts Forecasts

• Related New Starts requirements
• A framework
• Framing uncertainties in forecasts
Related Requirements

- FTA ratings: to consider reliability of numbers
- Analysis of uncertainty: to support ratings
- Before-After studies: to improve understanding and tools
- FFGA Bonus Awards: to provide incentives
- Performance Tracking: to promote good practice
A Framework for Dealing with Uncertainty and Accuracy in Forecasts for New Starts Projects
Uncertainty Analysis

• Potentially a central role
• Lessons from colleagues?
  – Weather forecasters
  – Travel forecasters
Uncertainty Analysis

• An approach?
  – "Forecast" of current conditions and travel patterns

  What things must happen to get us from here to there?

  Performance of project
  Growth
  Highway congestion
  Parking prices
  Fares
  Etc., etc., etc.

  – Forecast of future conditions, travel patterns, and performance of a New Starts project
Framing Uncertainties

• Stepwise build-up of forecasts
  – Today
  – Plus the future transit network
  – Plus future trip tables
  – Plus future highway congestion
  – Plus future parking costs

• Isolation of contributions to full forecast
Framing Uncertainties

• Assignment of probabilities to increments
  – Upper and lower bound?
  – Probability distribution?
  – Specific discussion of individual sources of uncertainty

• Range of possible outcomes
  – Separate forecasts (upper, lower, best-guess)?
  – Monte-Carlo → frequency distribution?
Questions

• How desirable is a redefined meaning to the term “forecast?”
• How possible is it to achieve, at least for the locally preferred alternative?
• What are the barriers?
14 – Tracking the Accuracy of Transit Forecasts

- The requirement
- Principles
- Implementation
Requirement

• SAFETEA-LU
  – Track performance of contractors in making reliable forecasts of costs and ridership
  – Account for the various sources of errors in the forecasts
A Framework for Dealing with Uncertainty and Accuracy in Forecasts for New Starts Projects
Principles

• Accountability appropriate generally
  – Contractors producing travel forecasts
  – Others producing travel forecasts
  – Project sponsors managing technical work
  – Project sponsors defining context
  – MPOs maintaining forecasting capabilities
  – MPOs making demographic forecasts

• So, track all participants
Principles

• Incentives for good practice
  – Current project ratings affected by:
    • Performance on previous projects
    • Current efforts (data collection, model upgrades, peer reviews, etc.)
  – Performance evaluation based on broadened definition of a “forecast”
Principles

• Performance
  – High score: Actual ridership ~ predicted ridership
    • For the right reasons?
    • Impact of offsetting errors?
  – Good score: Actual ridership < predicted ridership
    • Cause(s) documented in uncertainty analysis
    • Magnitude of impact ~ documented range
  – Bad score: Actual ridership < predicted ridership
    • Uncertainty analysis silent on cause(s)
    • Or characterized causes as very unlikely
Questions

• General approach useful?
• Appropriate implementation?
15 – Properties of Travel Models for New Starts Forecasting

- General requirements
- Specific issues
Topics

• General requirements
  – Calibration and validation (next session)
  – Ability to support coherent case for project

• Specific issues
Problematic Characteristics of Transit Forecasting Methods

- Unusual coefficients in mode choice models
- Non-logit decision rules
- Bizarre alternative-specific constants
- Alt-specific constants for “new New Starts”
- Path / mode-choice inconsistencies
- Accuracy of bus running times
- Stability of highway-assignment results
Unusual Coefficients

• IVT coefficients for HBW trips
  – Most models: -0.030 < Civt < -0.020
  – Variations: -0.045 < Civt < -0.007
  – Concern: Is this a reflection of behavior?
  – FTA caution: some further analysis appropriate if Civt < -0.03 or Civt > -0.02

• IVTTT coefficients for non-work trips
  – Civt for HNB trips ~ Civt for HBW trips
  – Civt for HBO trips ~ 0.1 to 0.5 x Civt HBW trips
Unusual Coefficients

- Large Covt/Civt ratios
  - Most models: $2.0 < \text{Covt/Civt} < 3.0$
  - Variations: Covt/Civt as low as 0.25! as high as 16!
  - Concern: different ridership gain and user benefits per minute of OVT
  - Concern: behavior or estimation error or distortion?
  - FTA requirements: compelling evidence if $2.0 < \text{Covt/Civt} < 3.0$
Unusual Coefficients

- Wide variations in LogSum coefficients
  - Problem
    - $0.7 < C_{\text{LogSum}} < 1.0 \approx \text{multinomial logit}$
    - Many models with “asserted” (not estimated) $C_{\text{LogSum}}$
  - Concern: overstated impacts on new transit trips & benefits(?)
Non-Logit Decision Rules

- “Thresholds” and “cliffs”
- Rules invented to improve reasonableness of forecasts
- Have random and sometimes extremely undesirable (+ or -) impacts on ridership and user benefits
Non-Logit Decision Rules

• Example 1:
  – Rule: 3 minute IVT minimum on transit
  – Motivation: eliminate very short transit trips
  – Undesirable impact: If project reduces transit time for an important interchange from 4 minutes to 2.9 minutes in CBD:
    • Transit share may drop from 25% to 0%
    • Potentially large negative benefits
Non-Logit Decision Rules

• Example 2:
  – Rule: For drive-access trips, transit IVT must be greater than drive access time
  – Motivation: Eliminate unlikely drive access transit trips
  – Undesirable impact: If project adds attractive close-in parking lot, rule may be violated
    • Transit share may drop to 0%
    • Potentially large negative benefits
Non-Logit Decision Rules

- Example 3:
  - Inconsistent access-coding rules across transit modes – guideways vs. local buses
  - Differences between alternatives caused solely by differences in access limitations
Non-Logit Decision Rules

• Conclusions:
  – Use continuous functions in disutility equation rather than 0/1 tests
  – Same relationships in path builders
  – Accept some degree of model inaccuracy in lieu of over-defined model process
  – Consider how models will react in forecasting differences between alternatives
Bizarre

Alternative-Specific Constants

• Problem
  – Naïve calibration $\rightarrow$ bad constants
  – Bad constants $\rightarrow$ large bogus utility changes
  – Bogus delta utilities $\rightarrow$ errors in trips & benefits
Bizarre Alternative-Specific Constants

A test for dominance of trip-table errors over behavioral content of alternative-specific constants... Is the pattern explainable?

\[ K_{\text{transit equiv mins}} \]

\begin{align*}
\text{Income class} & \quad 1 & 2 & 3 & 4 \\
\text{Plausible} & \quad & & & \\
\text{Implausible} & \quad & & & 
\end{align*}
Bizarre Alternative-Specific Constants

– Better calibration strategy: less “precision”?
  • Class-specific targets only for mode & access choices
  • Aggregate targets for transit line-haul choice

– Practical advantages
  • Line-haul target-shares do not have to be correct
  • Bizarre line-haul constants less likely

– Behavioral improvement?
  • Avoids implication that different classes value differently the unincluded attributes of line-haul choices
  • Resulting errors in line-haul-by-class highlight likely distortions in person-trip tables by class
“New” New Starts

• Transit constants for “new” New Starts
  – Some current systems inadequate to support calibration of constants representing:
    • “full” TSM (drive access)
    • “build” alternatives (guideways)
  – Difficulties with two common approaches
    • Borrowing constants from other urban models
    • Stated preference methods
  – Some insights from the AARF/CTPP model
  – Best handled as source of uncertainty?
Path / Mode-Choice Consistency

• Conformance between parameters in:
  – Transit path selection
  – Mode choice utility expressions for transit choices

• Consequences of disagreement
  – “Better” paths may look worse to mode choice
  – Build alternatives may lose some trips and benefits
Networks and Speeds

• Level-of service estimates must:
  – Replicate current conditions reasonably well
  – Predict defensible deltas: today vs. future
  – Predict defensible deltas: across alternatives

• Potential problems
  – Highway & bus link speeds → <2 mph
  – Imbalance between development and arterial capacity
Summary: Requirements

• Models are tools to provide insights
• Performance requirement
  – Provide basis for coherent statements
  – Usefulness, not perfection
16 – Calibration and Validation

- New Starts “standards”
- Meaningful calibration
- Useful validation
FTA Standards

• Reasons for travel forecasts
  – Insights into problems and alternatives
  – Information for decisionmaking

• Performance requirements for models
  – Ability to support a coherent story
  – Absences of fatal flaws
  – Usefulness, but not perfection
FTA Standards

• Evidence of a useful model set
  – Previewed in its specifications
  – Revealed by its forecasts (today, future)
  – Judged by the coherence of insights, story

• Elements of the story
  – Current and future (No-Build) conditions
  – Performance of the alternatives
  – Sources of transportation benefits
FTA Standards

• Traditional model development
  – **Estimation** of “behavioral” model parameters
  – **Calibration** of model adjustments
  – **Validation** of model forecasts vs. “today”
Calibration and Validation

Traditional model development

Potential problems

-- too much effort on estimation; not enough on calibration, validation
-- insufficient data on important travel behaviors
-- calibration factoring and rules, rather than real corrections
-- inattention to properties of “calibrated” models
-- forecasting started too late to inform calibration
Calibration

- Data
  - Highway travel times
  - Transit travel times
  - CTPP 2000
  - Transit rider survey (controlled sample)
  - Household diary survey
- Calibration should exhaust the data sources
Calibration

- Highway speeds
- Travel-pattern models
  - Trip ends by sub-area
  - Trip tables (sub-area to sub-area, by class)
- Calibration of transit-specific models
  - Transit link speeds
  - Transit pathbuilding *(assignment of survey data!)*
  - Transit-mode choice
  - Transit volumes – lines, stations, and lots
Validation

- Coherence of travel behaviors implied by the model
- Reasonableness of predicted changes
  - Between today and the future
  - Between base and build alternatives
Documentation

• Calibration
  – Description of key current transit markets
  – Demonstration of model understanding
  – Discussion of limitations in forecasting
    – Unobserved behaviors
    – Effects embedded in constants, K-factors

• Validation
  – Coherence of model properties
  – Reasonableness of predicted changes
FTA “Standards”

• Implications for New Starts
  – Early discussion of specifications → less chance of later problems
  – Better calibration/validation → better support for unusual characteristics in forecasts
  – Weaker calibration/validation → less latitude in FTA acceptance of forecasts
17 – Methods for Transit Data Collection

- Motivations
- Scope
- Approaches
Motivations

• Understanding of current role of transit
  – Major functions, markets
  – Context, part of making the case
• Informing travel models about transit
  – Models’ grasp of the major functions
  – Basis for ability to make useful forecasts
• Proposed regulatory requirement
• FTA-provided contractor assistance
Scope

- Relevant markets and transit services
- Sample size and distribution
- Sample control and expansion
- Necessary data items
Scope – Markets & Services

- Relevant markets and transit services
  - Nominally system-wide
  - Targeted corridors
    - Outlying commuter markets
    - CBD circulation markets
Scope – Sample Size

- Sample size and distribution
  - Less emphasis on line-level statistics
  - More attention to important travel markets
  - Sufficient sample to support tabulations by:
    - Geography: district-to-district flows
    - Socio-economic characteristic(s)
    - Transit line-haul modes
    - Access modes
Scope – Sample Control

• Sample control and expansion
  – Sampling plan
    • Dealing with sampling error
    • Controlling for non-response biases
  – Counts!
    • Stations
    • Access modes
    • Automated sources
## Scope – Data Items

<table>
<thead>
<tr>
<th>Necessary data items</th>
<th>Optional data items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trip origin and destination (O&amp;D)</td>
<td>First boarding (on) location</td>
</tr>
<tr>
<td>Activity purposes at the origin &amp; destination</td>
<td>Last alighting (off) location</td>
</tr>
<tr>
<td>Trip access and egress modes (O&amp;D)</td>
<td>Fare payment method</td>
</tr>
<tr>
<td>Park/ride location</td>
<td>Frequency of transit use</td>
</tr>
<tr>
<td>All transit lines used for the trip</td>
<td>Other household characteristics</td>
</tr>
<tr>
<td>Driver’s license (or ability to drive)</td>
<td>Other personal characteristics</td>
</tr>
<tr>
<td>Household vehicles</td>
<td>Satisfaction with service</td>
</tr>
<tr>
<td>Household workers</td>
<td></td>
</tr>
</tbody>
</table>

----- subject to revision -----

June 2006
Approaches

- **Surveys of Riders**
  - On-board
  - At stop
  - Park-ride lots

- **Counts**
  - Boardings
  - Parking lot occupancy

- **Other**
  - On-time performance
  - Financial
  - Fare-box data
Surveys of Riders

- Information to be gathered
  - Rider characteristics
  - Characteristics of rider’s household
  - Trip characteristics
    - Purpose
    - Origin/destination
    - Modes of access/egress
    - Frequency of trip
On-board Surveys

- Must be coordinated with counts to permit expansion
- Self-administered
  - Response bias
  - Incorrect information
  - Largest sample (distributed, maybe not returned)
- Interviews
  - Smaller sample
  - Difficulty with short trips
  - More accurate information
Approaches to dealing with multiple trip problem

- Surveying travel in only one direction (e.g. inbound)
- Surveying travel only during a portion of the day (e.g. start-of-service until 2 PM) and assuming travel symmetry
- Asking riders if they were previously surveyed or if they will make a return trip.
- Asking riders to complete a survey on all trips and trip segments.
At-stop Surveys

- Consider for projects with “stations”
- Requires interviewers
Park-ride Lots

- Windshield mail-back
- Interviews
Counts

- Boardings by stop or station
- Departures by stop or station
- Persons on-board by link or segment
- Vehicles in parking lots
Other Data Types and Sources

- On-time performance
  - Of interest for certain types of projects (e.g. BRT)
  - AVL systems may be used if available
- Financial data
  - Revenues achieved
- Farebox data
  - Boardings by payment type (buses)
  - Boardings by day of week and time of day
Information to Be Gathered

• Definition of markets
  – Who is riding and for what purposes?
• Analysis of travel demand models
  – Identify independent variables in models
  – Collect these data
18 – Preservation and Analysis of New Starts Travel Forecasts

- Motivations and objectives
- Preservation
- Before-After / Predicted-Actual Studies
Motivations

• Before-After Studies
  – Required since the 2001 New Starts rule
  – Include comparison of forecasts with actuals
• Tracking of “contractor” performance
  – SAFETEA-LU
  – Includes identification of sources of error
• FTA Predicted-Actual study: few records!
Preservation

- Milestones
  - Entry into preliminary engineering
  - Entry into final design (and FFGA?)
- Forecasts for build & baseline alternatives
- Preservation of insights
  - Dangers of postponing analysis until “after”
  - So, analysis of changes at milestones
Preservation

• Possible approaches
  – Preserve the numbers only
    • Save files (zone attributes, trip tables, etc.)
    • Rely on forensics to understand changes, errors
    • Challenges in allocating causes of errors
  – Preserve ability to recreate the forecasts
    • Networks, models, reporting tools
    • Much better platform for isolating causes
    • Challenges with software, hardware, zones, etc.
Preservation

• Providing continuity
  – Project sponsors responsible for B&A study
  – Consultants or MPO often prepare the forecasts
• Preservation as a wrap-up task in forecasting
• Active FTA role in preservation
  – Back-up plan for sponsor & contractor archives
  – FTA contractor: obtain, test, and archive
    • Ability to replicate forecasts
    • Analysis of changes in forecasts since previous milestone
Implementation

• Before-After Studies
  – Since 2001

• Preservation and analysis at milestones
  – 2006 “Policy Guidance”

• Applicability
  – Projects without FFGAs by guidance date
  – Projects entering PE after guidance date
Barriers?

- Challenges?
  - Software and hardware?
  - Changes in zone systems?
  - Others?

- What should FTA be doing to help?